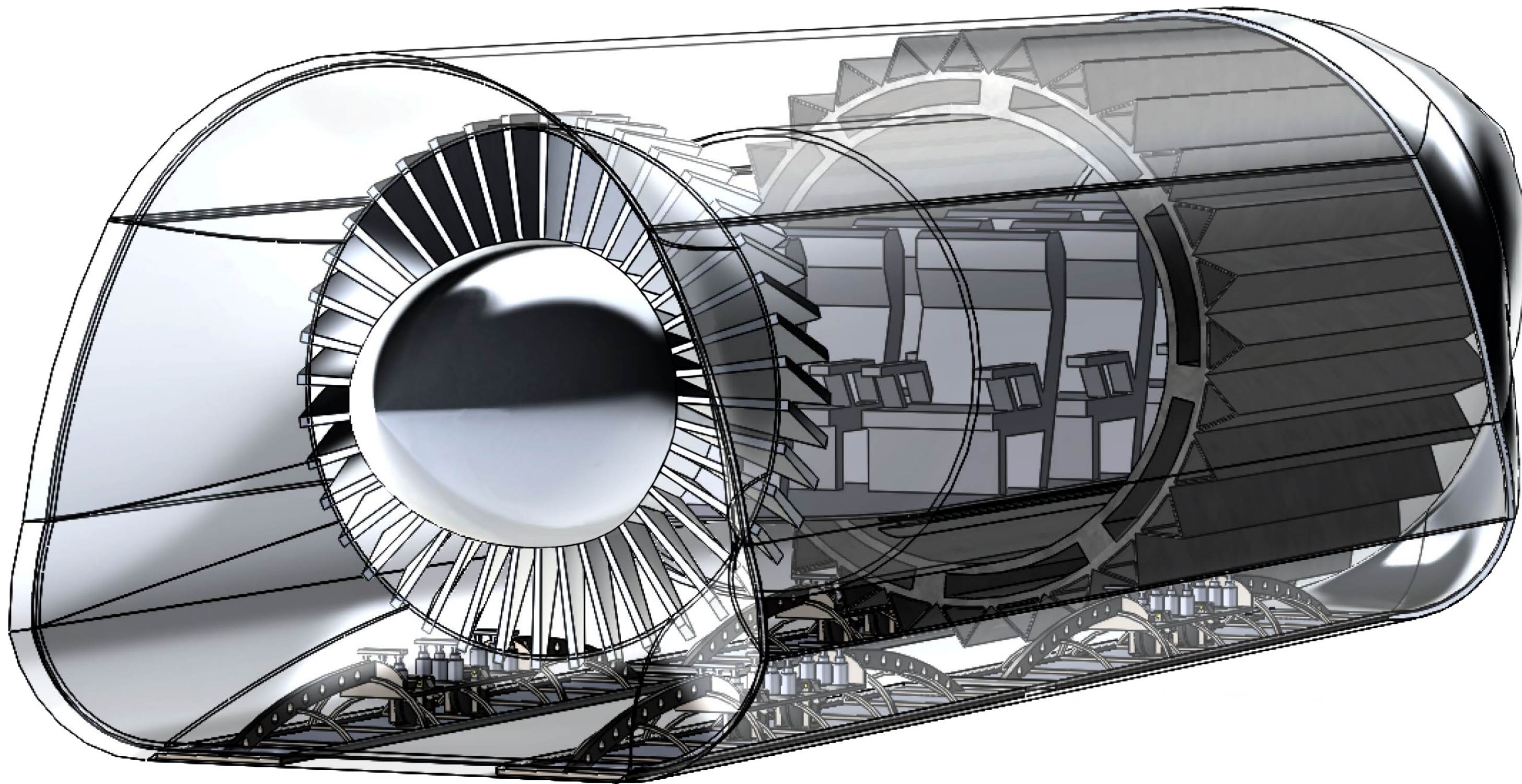


DVC HYPERLOOP TEAM Z-TYPHON



EXPLODED VIEW OF CAPSULE

Nose Cone

The nose cone went through multiple stages of evolution starting around the von Karman nose developed for minimum air drag.

Ring Motor

The ring motor is our method of intake of air through the front of the capsule to expel air through the exhaust as well as propel us forward and keep us levitated through air dispersal to these areas and the air skis.

Passenger Cabin and Seats

The passenger cabin was our design to include the principal of passenger travel through the tube, and we designed a mechanism for the capsule to hold the passengers safely and economically feasible.

Tail Cone

The tail cone is for aerodynamic flow of the pod and it has a hole for exhaust that we send a jet of air out for propulsion and release of extra air compressed via the compressor.

Air Sleeve

The air sleeve went through heavy analysis both analytically, as well as aesthetically through the design process. We developed a method of finding a shape that we feel is appropriate based off the constraints given to us via the SpaceX competition rules. The Air Sleeve is a unique feature for our design and is characterized by intake through the front, which contains room for a ring motor, air skis, a passenger cabin, and an air folding system.

Air Skis

The air skis are our levitation mechanism and they include wheels and suspension in the case that the capsule jolts upward and slams back down to the ground so that the capsule does not falter in the tube and stays parallel to the track as well as maintaining distance to the track by resupplying the loss of air gap.

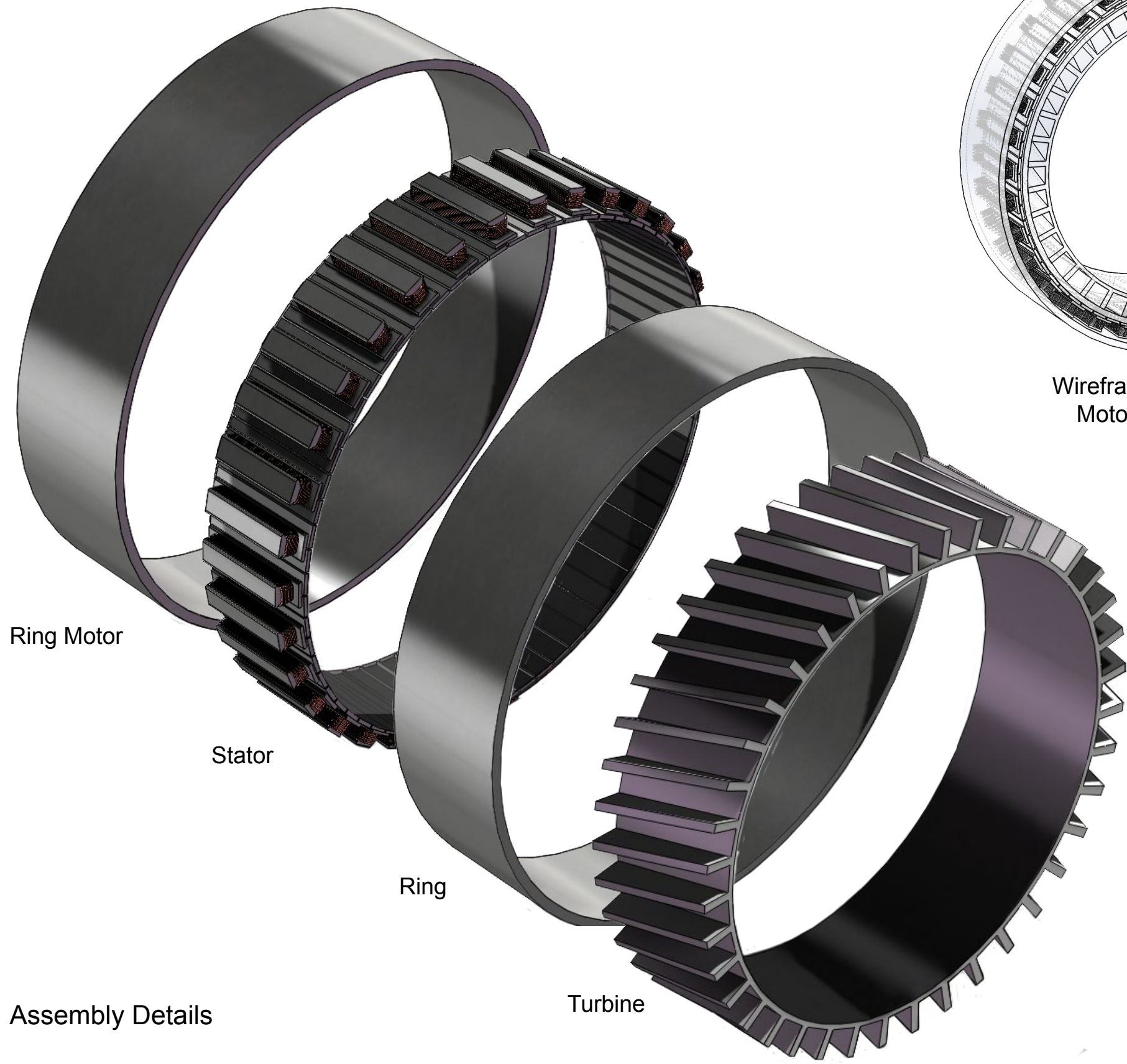
Air Fold

The air folding mechanisms are there for added protection to make sure that cracks in either passenger cabin and also in the air sleeve remained sealed through vacuum sealant. Also, the air fold contains room for our batteries, air supply to the passengers, steam, water, wiring, and tubing. This also allows for added layers of protection between the depressurized inerts of the tube and the atmospheric pressured passenger cabin.

Adapter Plate to Tail Cone

The adapter plate and the tail cone are both for aerodynamic flow of air as well as a hatch to allow the passenger cabin to pull out from the inerts of the air sleeve, so passengers can enter and exit the capsule efficiently, quickly, and comfortably.

RING MOTOR + TURBINE MECHANISM



Ring Motor

Stator

Ring

Turbine

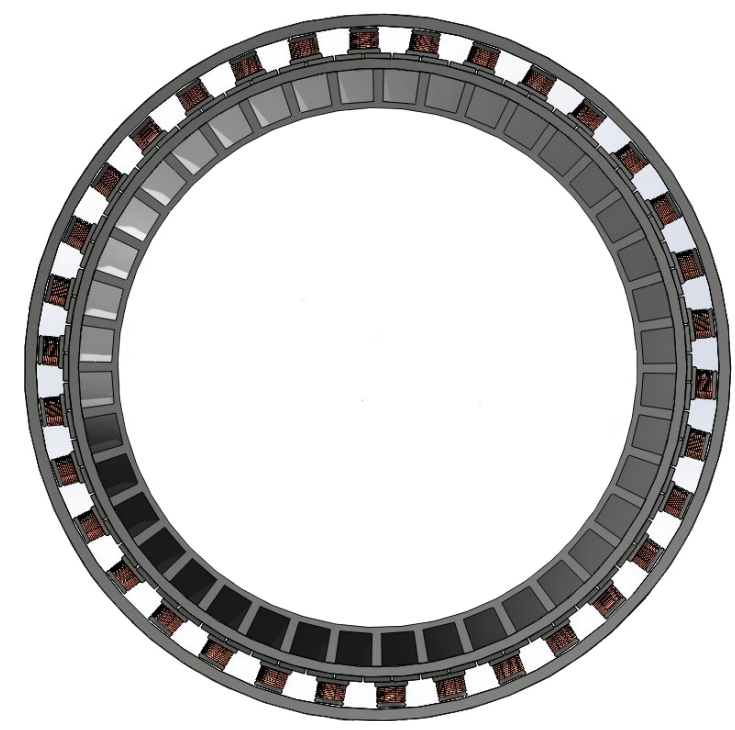
Assembly Details



Wireframe View of Ring Motor and Turbine



Perspective View of Ring Motor and Turbine



Front View of Ring Motor and Turbine

The ring motor is made of aluminum and coated with a zinc alloy for protection.

The ring motor will be used in several forms of adjustable speed drive.

The variable-speed drives recover slip frequency power from the rotor circuit and feed it back to the supply, allowing wide speed range with high energy efficiency.

The turbine is connected to the rotor assembly, which is a shaft or drum with the blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor.

AIR SLEEVE FOLDING

Description of Folding

Using the following we derived the air sleeve folding for our capsule. The Air Sleeve folding is for added protection to the passengers and pod, as well as providing air storage, battery storage, plus wiring storage for our pod. We assumed that we should have folds every fifteen degrees or less for a good fit. The amount of folds are 28 per circumference. We will be looking into deriving an equation for finding the best amount of folds for pod storage and safety.

$$l = 2\pi r, l_1 = \frac{l}{28} = \frac{2\pi r}{28} = \frac{\pi r}{14}$$

$r = 16in$

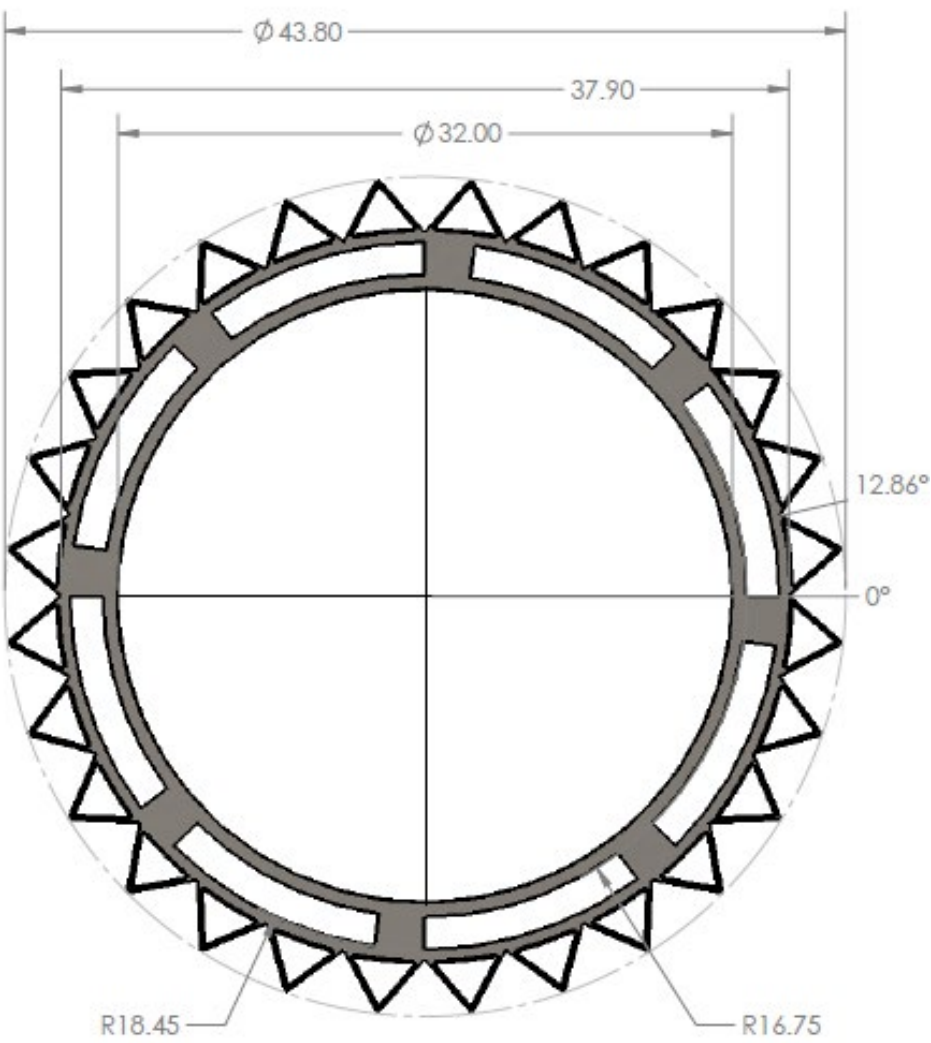
Using Solidworks we made a design for the folding of the air sleeve, and the photo here shows the design.

The folding does not occur the entire way through the inner section of the pod. The folding occurs on the outside of the passenger pod, and in between the compressor and air ski two or so times. This design could be implemented the entire way through after the compressor zone in a full scale mock up of the pod. Potentially for use in the Hyperloop Capsule.

Safety Features of Air Sleeve Folding

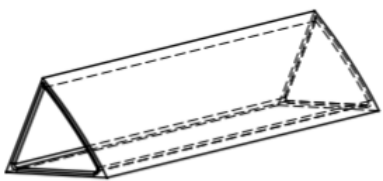
The safety features of the Air Sleeve Folds are the following:

- A secure fit for passenger safety (no rotating)
- Storage for Air and Battery
- A safety mechanism for potential passengers via the anti-pressure material between the inner protective layer and the storage units



Dimensions, Spacing, and Mathematics

Diameters of the circular rings in the folding apparatus. Using the equation for the circumference of a circle we developed a length for one twenty-eighth of the entire circle allowing for twenty eight triangles. We then took the tangent to the mid section of the triangle to create equilateral triangles with a base that is curved around the 37.90 inch diameter circle below. There are bars in between the outer structure that connects the triangles and the inner structure that holds the protective metal to prevent leaking of air from the inner passenger cabin. The inside of the triangles are filleted to 0.1in to decrease the ability of cracking or wear on the inner edges of the triangles. To the right and down is a picture of one triangular prism that will fit in between the triangular prisms that are shown below. These images are not to scale.



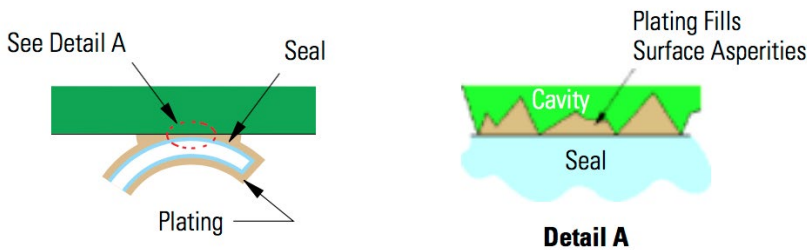
This is a sketch of the outer portion of the folding, where these pieces will fit in between the triangular prisms of the folding that is attached to the passenger pod.

Vacuum Sealant Material

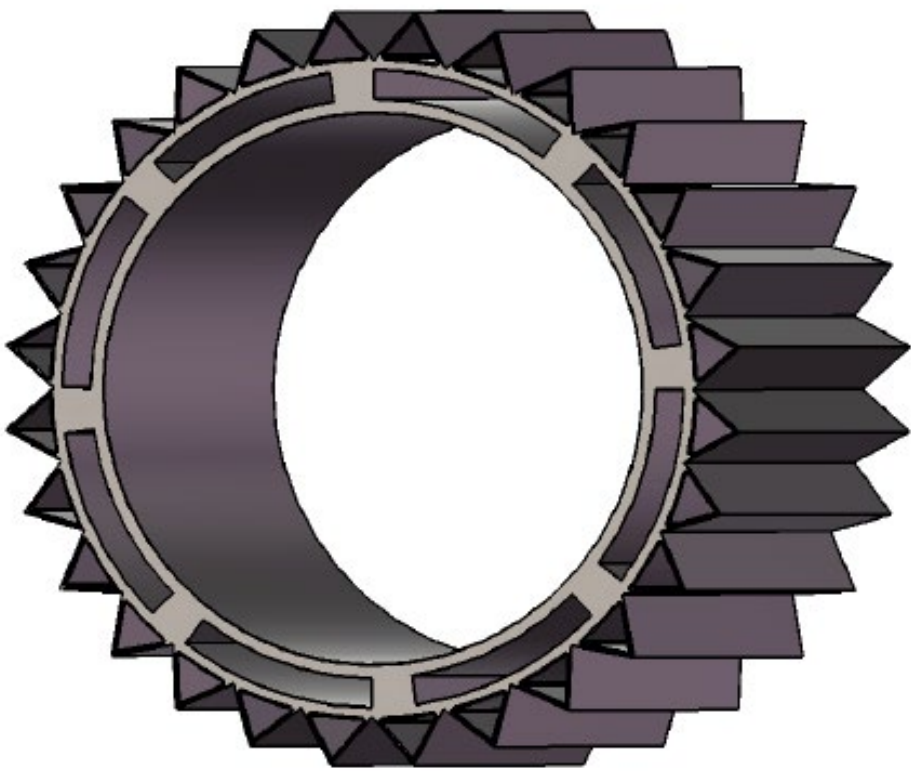
The proposed idea is to have vacuum sealant** such as C-Seal manufactured by Herber Aircraft in the ring cavity between the triangular prisms, and the inner protective layer of the outside of the passenger capsule. In the case of a crack or puncture in the outer portion of the capsule, and if this crack manages to open towards the center of the pod. The pod will contain this sealant to fill a crack instantly, so passengers are safe. Also, if a crack forms on the inner layer, then the sealant will be able to seal that portion of the pod.

FIGURE 1-1

Purpose of Plating



The above figure is taken from the Eaton Aerospace Operations Resilient Metallic Sealant catalog.



**See the Hazardous Materials poster for more information on the Vacuum Sealant Material proposed in the inside of the Folding Structure.

“Aerospace.” Science News 99.24 (1971): 403. Eaton. Web. 6 Nov. 2015.

AIR SLEEVE

Description of the Air Sleeve: Process and Arrival at a Final Design

We developed the idea early on to include an air sleeve in our design, which would surround and encapsulate our pod. The reason why chose the air sleeve is because it fit well with our intentions of taking in air with a ring motor and compressor that would pull air in through the front instead of a traditional fan.

Through thought about how to make an air sleeve mathematically to optimize for maximum area, volume, and aerodynamics we developed a method to calculate and shape our air sleeve through three ellipses that would change the height of the mid-section with the largest width available to the design (4.5-ft as noted in the competition rules). Through this we kept the same width bottom at a maximum of 3.5-ft, and allowed the height to maintain 3.75-ft. While changing the height of the height of the quarter arc of one ellipse on either side while allowing for a ellipse to cover the upper portion of the capsule. We developed a matheimcal approach to find volume, area, and shape of the pod (see Figure (1) for more detail on the math.

To the left are a couple of the body designs that we came up with. We also made a variety of lengths for each change in height of the maximum width location. The purpose was to send these into design and have each one go through the flow simulator once we have finished our concept.

However, we ended up not going with this approach, it did allow us to find a way to potentially maximize the area of our pod by placing the 4.5-ft maximum width at a certain location that is intuitively aerodynamic and aesthetically pleasing through thought on what makes aircraft, cars, and other vehicles have their unique low drag qualities.

Body Dimension Analysis:

Using an xy-coordinate system with the origin based at (0,0), I derived four equations that I can use to make different shapes for the capsule, and I applied a variable called y2 which is the distance between the bottom of the capsule to the height where the max width is located.

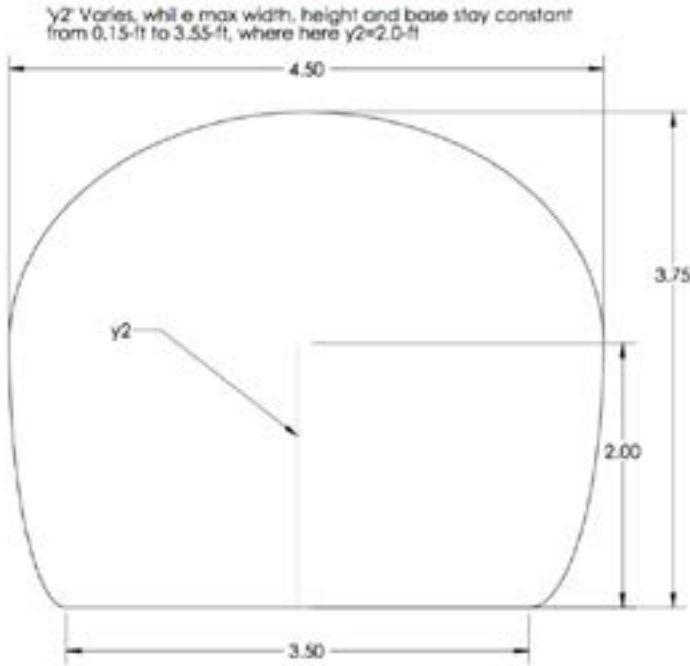


Figure 1: Hyperloop Shell Design (Capsule and Air Sleeve) Refer to equations (1), (2), and (3) in equation key below.

Equation 1 (Left Ellipse):

$$\frac{(x + 1.75 \text{ ft})^2}{0.75^2} + \frac{(y - y_2)^2}{y_2^2} = 1$$

Equation 2 (Right Ellipse):

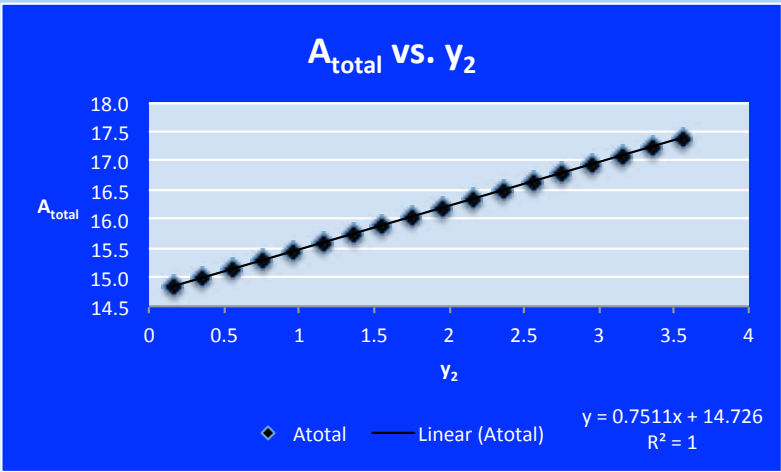
$$\frac{(x - 1.75 \text{ ft})^2}{0.75^2} + \frac{(y - y_2)^2}{y_2^2} = 1$$

Equation 3 (Top Ellipse):

$$\frac{x^2}{2.5 \text{ ft}^2} + \frac{(y - y_2)^2}{(3.75 \text{ ft} - y_2)^2} = 1$$

```
Program:
clc, clear
% Body_Dimension_Design_Equations.m

% In this program I calculate different
equations for a fully elliptical
% design, and a semi-circular and elliptical
design.
%
% bw=[3.5]; %ft base width
% mw=[4.5]; %ft max width
% mh=[3.75]; %ft max height
syms x y y2;
eq_1=sym('1=((x-
+1.75)^2)/0.75^2+((y-y2)^2)/(y2^2)')
eq_2=sym('1=(x-1.75)^2/(0.75^2)+(y-
y2)^2/(y2^2)')
eq_3=sym('1=(x^2)/(2.5)^2+(y-y2)^2/(
(3.75-y2)^2)')
y_2=0.15:0.2:3.55
A1=(2.5).*(3.75-y_2).*pi
A2=(0.75).*(y_2).*pi
A3=A2
A_box=y_2.*3.5
A_total=(A1./2)+(A2./4+A3./4)+(A_box)
V_total=A_total.*14
eq_1_1=subs(eq_1,[y2],[y_2(1)])
eq_2_1=subs(eq_2,[y2],[y_2(1)])
```



Graph (1): Total Area vs. the Change in Height of the Maximum Width (4.5-ft)

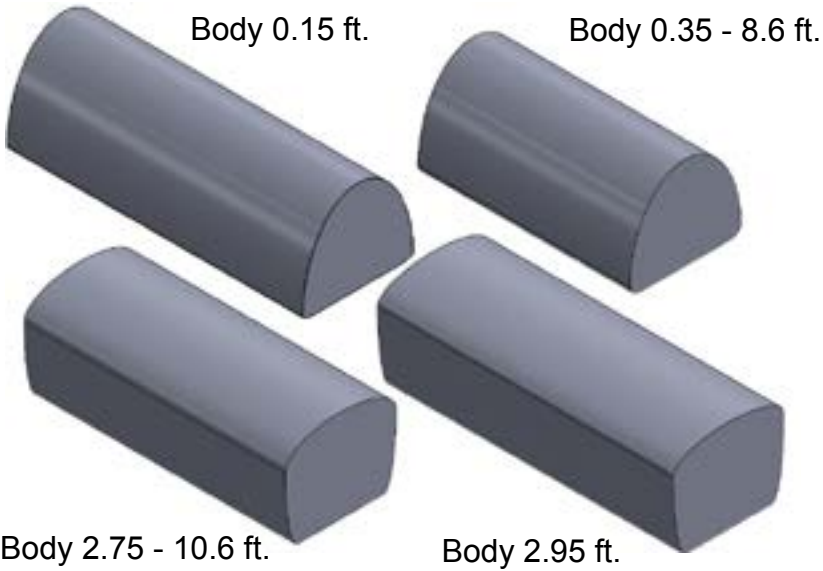


Figure (2): Different Early Body Designs Based Off Ellipses The method of making different body designs based off of ellipses and a change in the vertical distance where the maximum width was placed helped us to understand the constraints that the competition rules gave us for our final design that is included in this preliminary briefing.

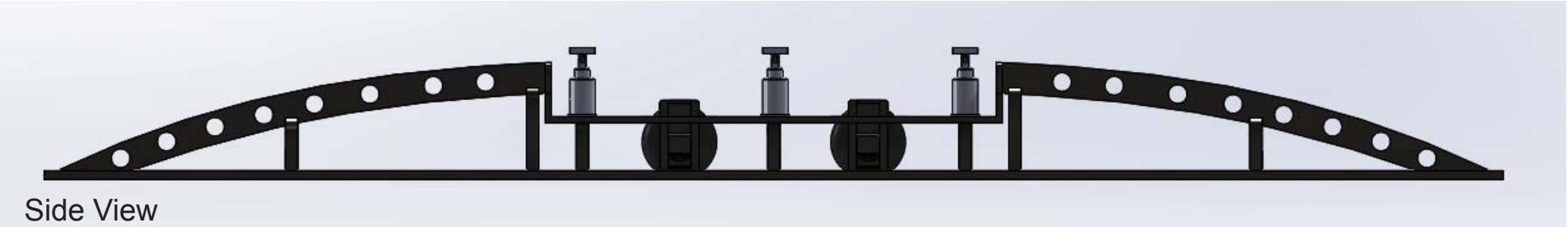
Data for Elliptical Shell Structure Area and Volume Data					
y ₂	A ₁	A ₂ and A ₃	A _{box}	A _{total}	V _{total}
0.15	28.3	0.353	0.525	14.8	208
0.35	26.7	0.82	1.23	15.0	210
0.55	25.1	1.30	1.93	15.1	212
0.75	23.6	1.77	2.63	15.3	214
0.95	22.0	2.24	3.33	15.4	216
1.15	20.4	2.71	4.03	15.6	218
1.35	18.8	3.18	4.73	15.7	220
1.55	17.3	3.65	5.43	15.9	222
1.75	15.7	4.12	6.13	16.0	225
1.95	14.1	4.59	6.83	16.2	227
2.15	12.6	5.07	7.53	16.3	229
2.35	11.0	5.54	8.23	16.5	231
2.55	9.42	6.01	8.93	16.6	233
2.75	7.85	6.48	9.63	16.8	235
2.95	6.28	6.95	10.33	16.9	237
3.15	4.71	7.42	11.03	17.1	239
3.35	3.14	7.89	11.73	17.2	241
3.55	1.57	8.36	12.43	17.4	243

Table (1): Data of Area Segments to calculate Volume including Elliptical Areas and Box Areas

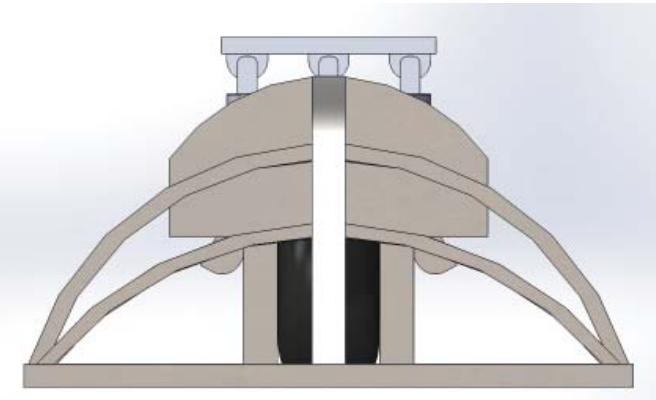
Brief Description of our Design

Our air ski has 4 distinct parts. These are the actual ski surface, the support structure, the shock absorbers and the wheel section.

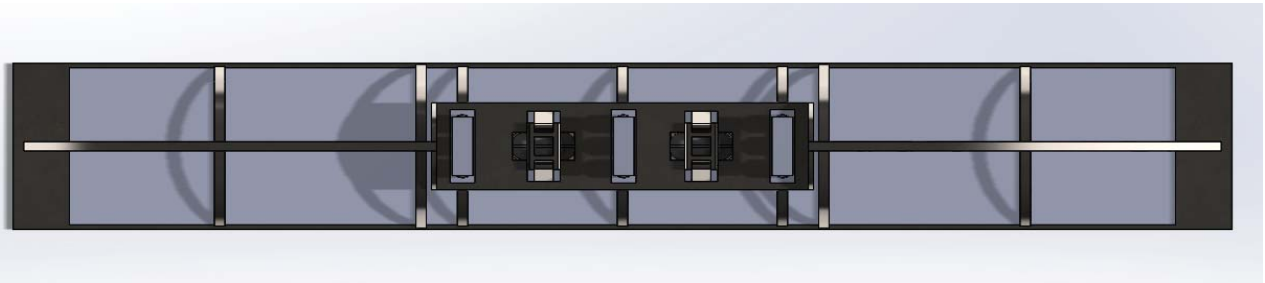
- The ski surface could be scaled up to a maximum of 58.2 inches by 8.5 inches, providing about 40 square feet of lifting surface, with the final size being determined by future testing.
- The support structure would be made of aircraft-grade aluminum with cutouts to reduce weight.
- The shock absorbers would be in groups of three on each ski support structure and would be used to maintain the 0.05 degree angle of the ski. These shocks would ideally be some sort of air-ride system but could alternatively be pneumatic.
- The wheel section would consist of the wheel emergency deployment system, which would serve as our wheel deployment system, and the braking system.
- There would also be various air hoses and pneumatic fluid lines not shown in the drawing.



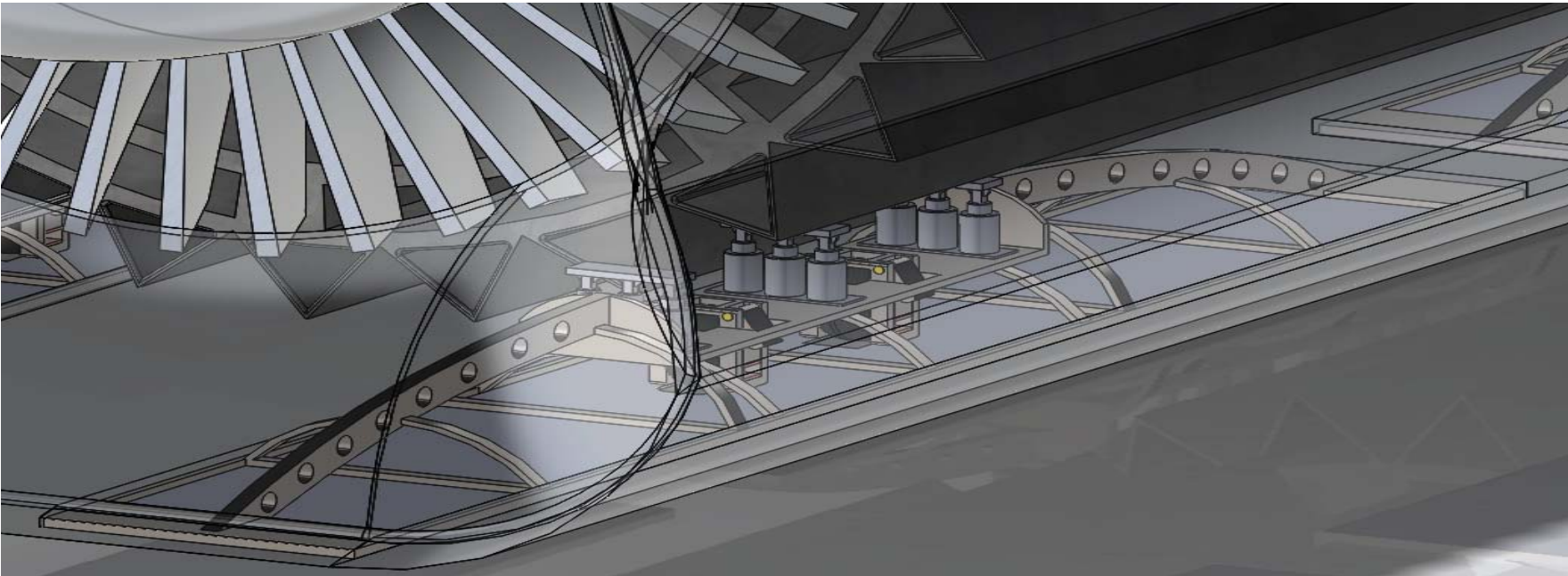
Side View



Front View



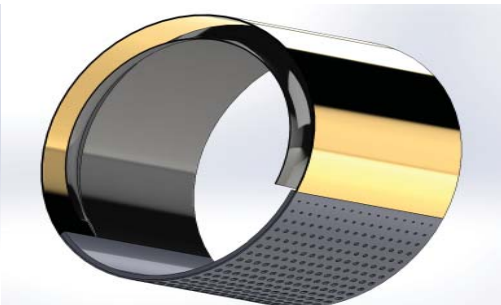
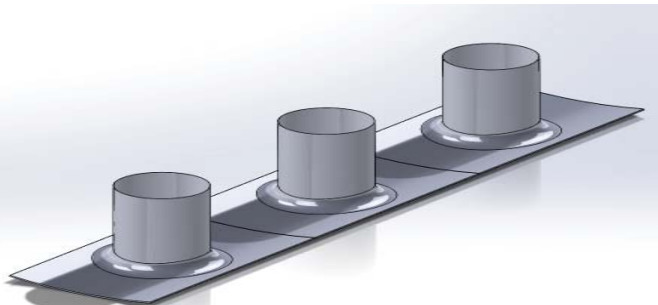
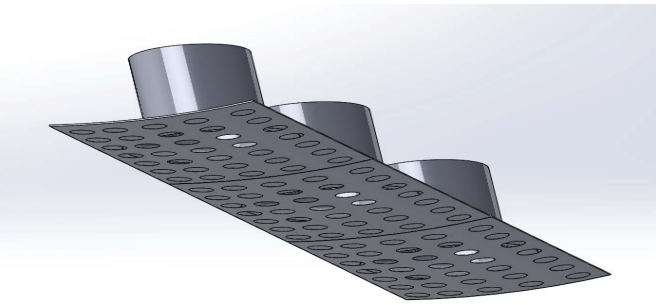
Top View



Ski in Pod

Analysis

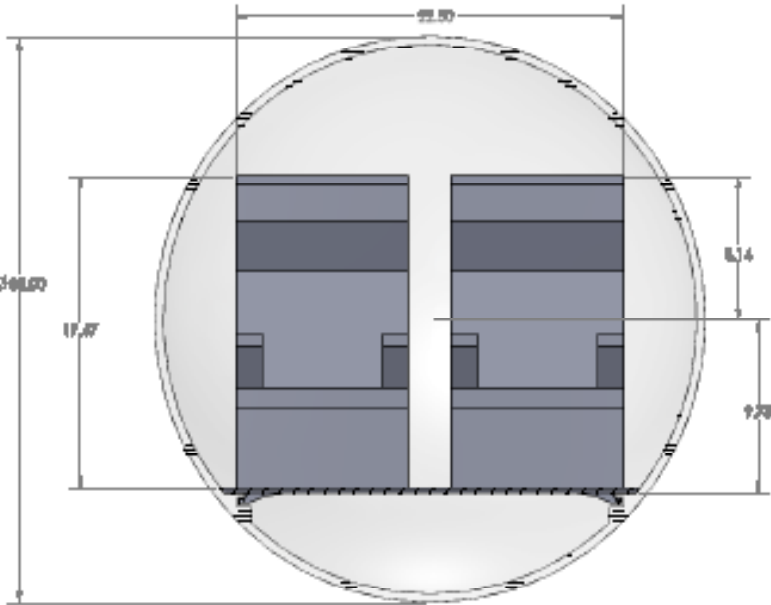
Ski Surface Area:	41 ft^2 maximum per ski
Air Exit Pressure:	2.5psi
Capacity(lbs):`	5000lbs
Flow Rate:	100 CFM
Ski Weight:	18.3lbs per ski
Wheel Deployment Speed:	200 m/h



Previous Ideas



PASSENGER CABIN AND ESCAPE POD



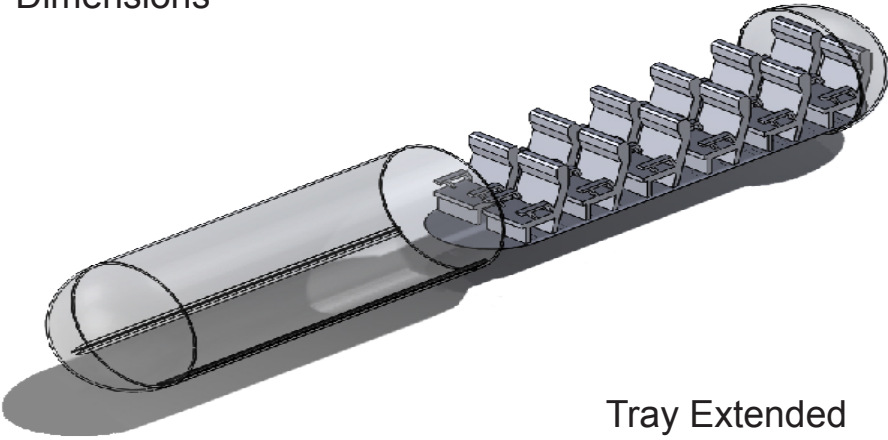
Dimensions

Slide-Tray

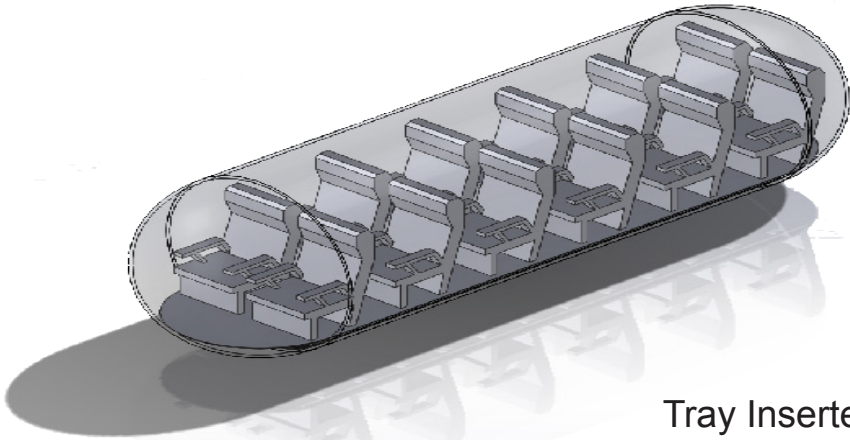
Our method of loading and unloading passengers is rather unique. Instead of using a conventional approach and having the embarkation points be located along the sides of the craft, we instead have a single embarkation point located at the rear of the craft. This allows us to use the space previously required for the doors to used for equipment placement.

The slide tray itself is fairly simple. It consists of a reinforced ‘tray’ that slides in and out of the passenger compartment upon ball bearings. These bearings are set into a track that also serves to guide and secure the tray. The back section of the tray is fixed to the removable rear section of the pod.

To embark, the tray would slide out and be moved to the designated loading area where the passengers would seat themselves. Once the passengers have taken their seats and fastened their restraints, the tray would be inserted into the passenger compartment and locked in place. To disembark, the process would be reversed, with the try being removed and the passengers disembarking in the designated area.



Tray Extended

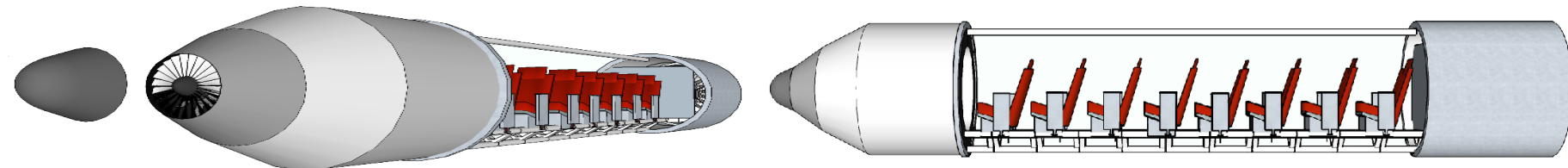


Tray Inserted

Safety Features

The passenger compartment’s safety systems would, like most of the other systems aboard the craft, have much in common with commercial airliner safety systems. The passenger compartment is isolated from the rest of the craft, making it difficult for debris to penetrate the cabin. There would be a manually-operated emergency escape mechanism in case the passengers needed to perform an emergency disembarkation and drop-down air masks.

The emergency escape mechanism would consist of an unlocking device (located by the rearmost seats) that would allow the user to manually break the pressure seal once the external tube pressure reaches acceptable levels for humans and a pulley system (whose controls would be located by the frontmost seats) that would then allow the user to manually expell the passenger compartment by sliding it out in a similar fashion to the loading and unloading of the passenger compartment. The passengers would then escape the tube via escape stairs, similar to those used by the BART system.

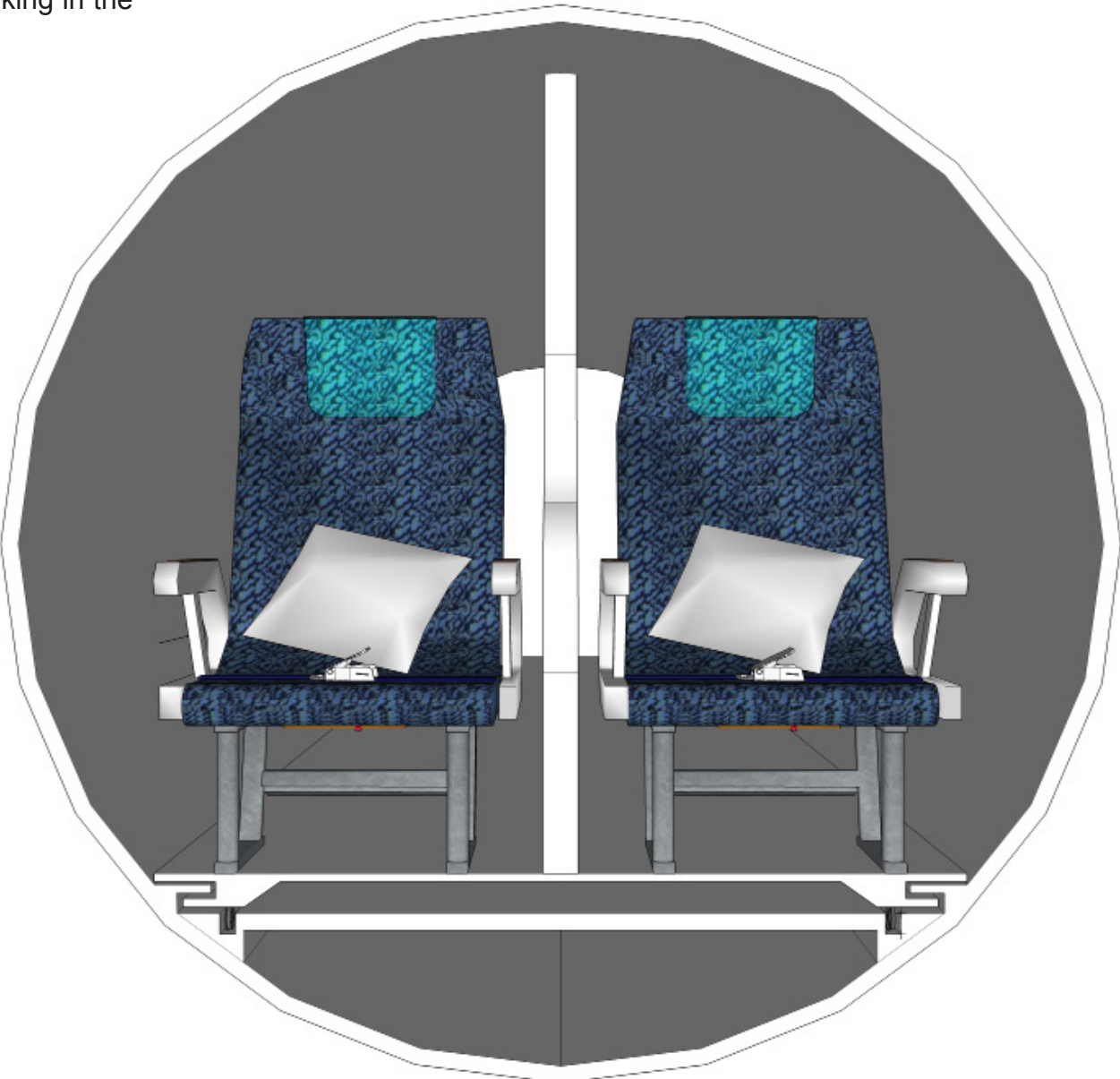


Previous Ideas

Life Support Systems

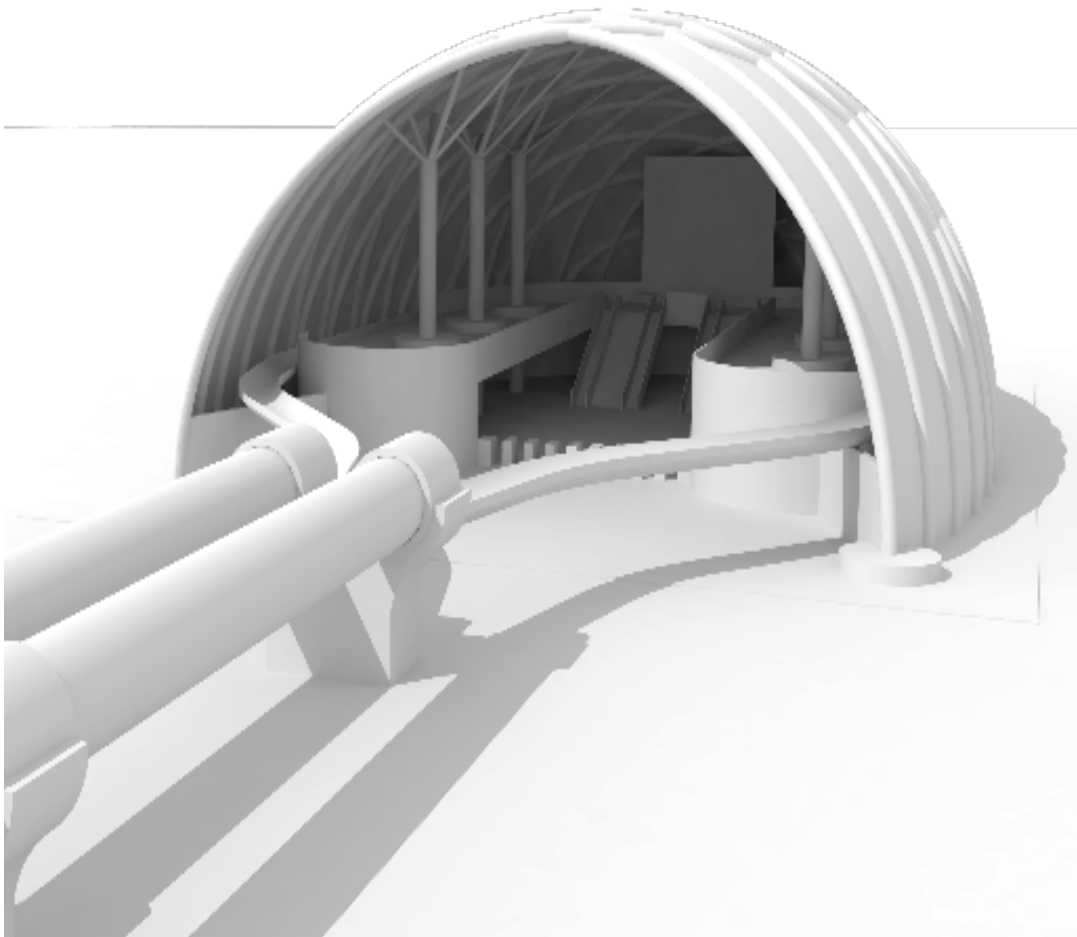
Our passenger compartment would feature life support systems similar to those aboard commercial aircraft. These systems would be contained within the compartment and have their own power sources seperate from the main power grid.

We would include an air supply, emergency depressurization masks, an interior HV/AC system, and an air filtration system. The air supply would be comprised of at least 3 pressurized air tanks pressurized to 200 bar and would hold an approxamite 700 cubic feet of air at sea level air pressure. The emergency masks would be similar to the ones aboard commercial airliners and would help combat the effects of a slow air leak. The HV/AC system would be cooled by the general coolant system and the air filtration system would consist of a traditional HEPA filter connected to the cabin intake air supply.



Section Rendering

PASSENGER LOADING



Full Station

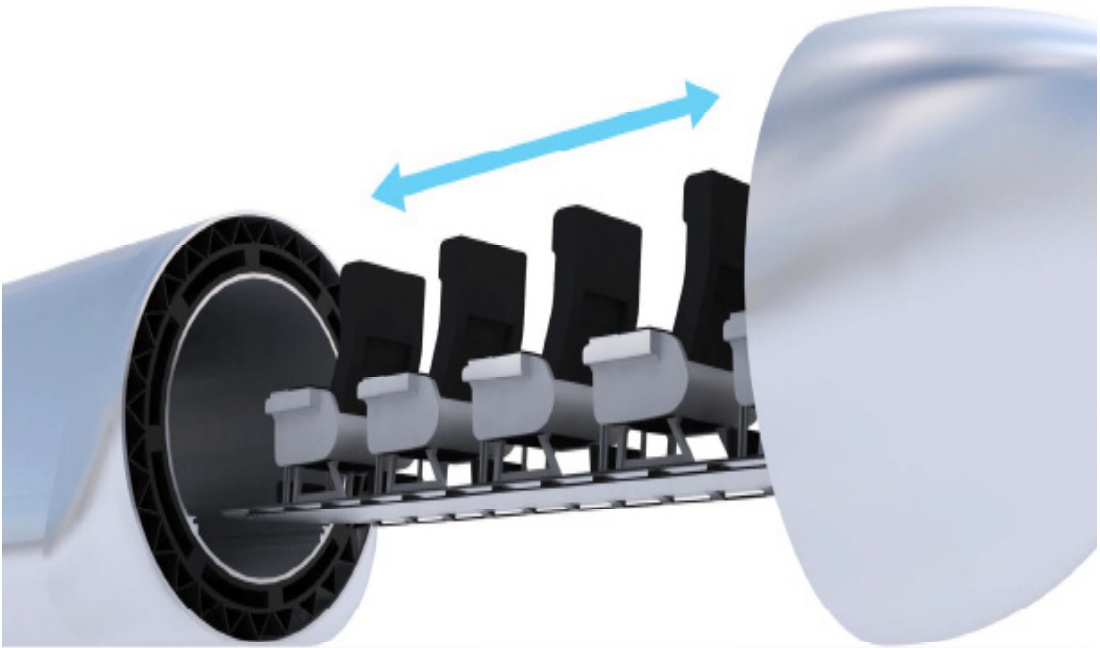
Loading Process

The overall process will have much in common with the loading of people onto existing mass transit systems, such as the BART system and New York City’s subway system. The passengers would purchase a ticket and then be allowed onto the loading platform, where they would wait for the next available pod.

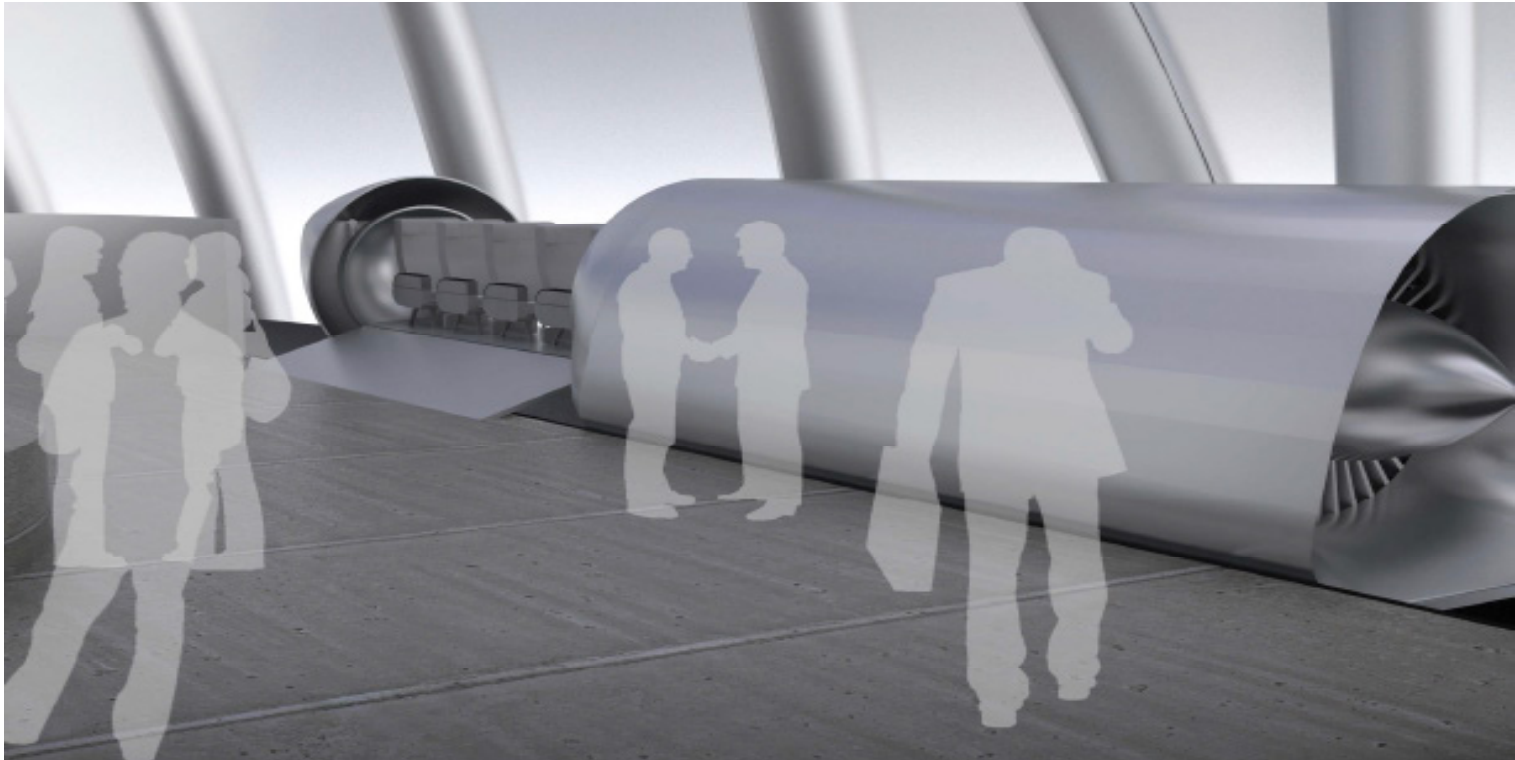
Where the Hyperloop differs from conventional systems is in the way the passengers actually embark. The pod will disembark passengers on one side of the track, continue around the curve, and embark passengers on the other side. Any changing of air tanks or other parts will take place during the pod’s transit around the curve.

A more detailed description is as follows:

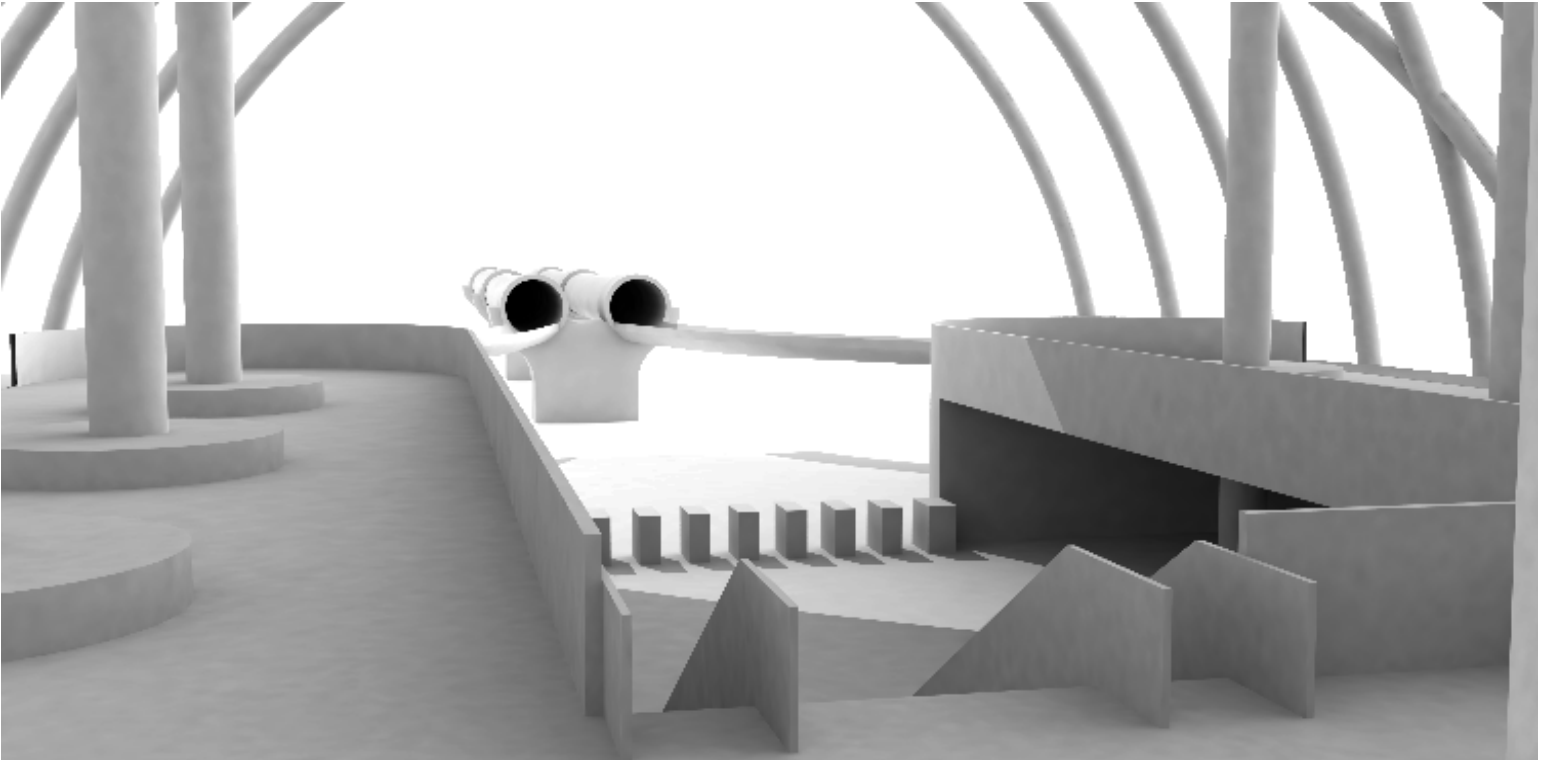
Once the pod reaches the unloading zone the passenger cabin will unseal and slide out, allowing a transit ramp to deploy to allow the passengers to disembark. Once all of the passengers have disembarked, the transit ramp will retract, the passenger compartment will re-seal, and the pod will undergo a brief full systems check on its way around the curve. Upon its arrival on the other side of the platform, the proces will repeat in reverse. The pod would then enter the departing airlock and be on its way.



Pod Loading

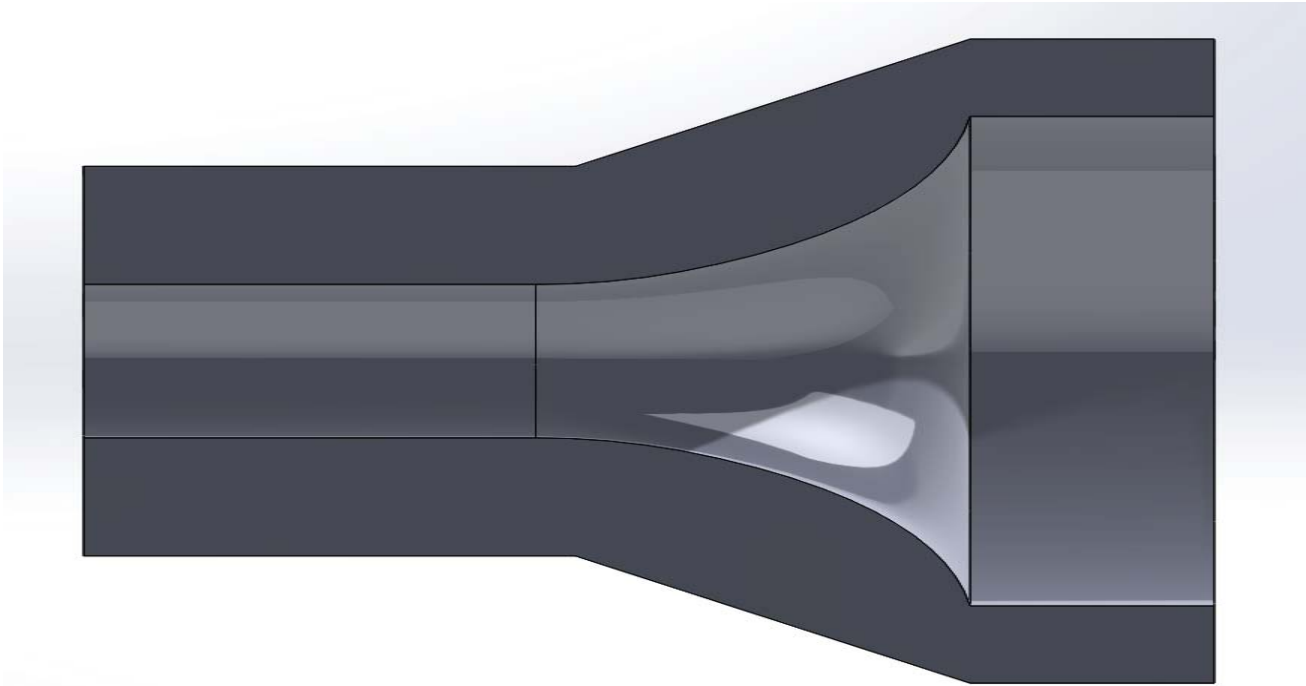


Passengers Loading



View of Tubes

EXHAUST SYSTEMS



Possible Expansion Nozzle

Air Exhaust

Our air exhaust system is essentially just a means to bypass the enormous quantity of air that will need to be ingested. The vast majority of the air will flow from the front ring motor through the folds in the main body structure and out an expander nozzle at the rear of the craft. What little air there is that doesn't follow this path will be routed to the air skis to be used to levitate the craft.

The expander nozzle will most likely not provide any appreciable thrust, but it can't hurt to include it.

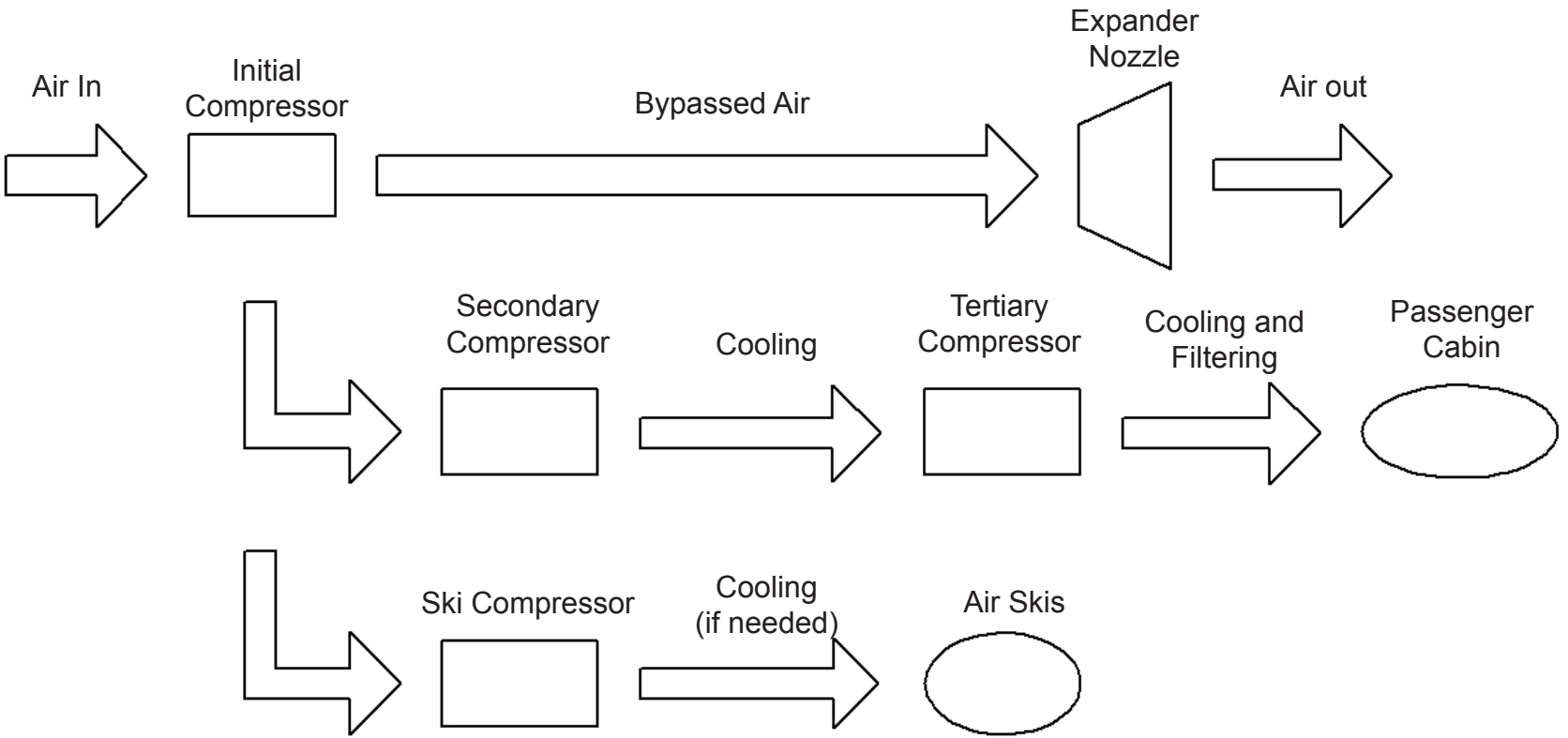
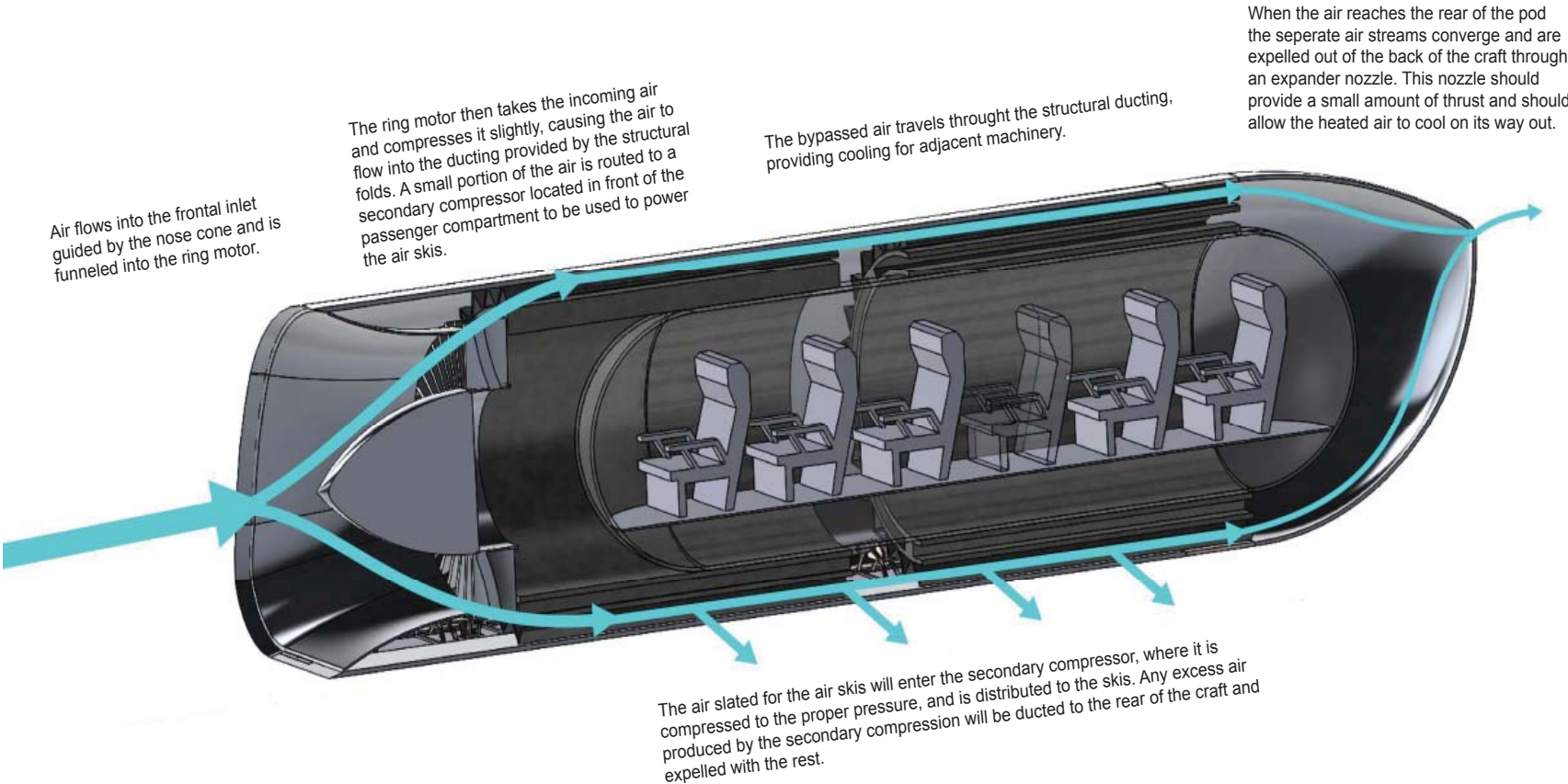
The air exhaust system will also double as the main source of cooling, and leaves us with the option of also including an intercooler for additional cooling.

Thermal Exhaust

As mentioned above, the thermal exhaust system ties in with the air exhaust system. The air ducting running alongside the passenger compartment will help cool the excess heat from the compartment and will remain separate from the machinery-cooling air until the air is expelled. This is to prevent the waste heat from the machinery from bleeding into the passenger compartment.

NOTE:

We will most likely not be using bypassed air as an air supply for the passengers, due to the extreme level of filtering needed to make the air breathable.



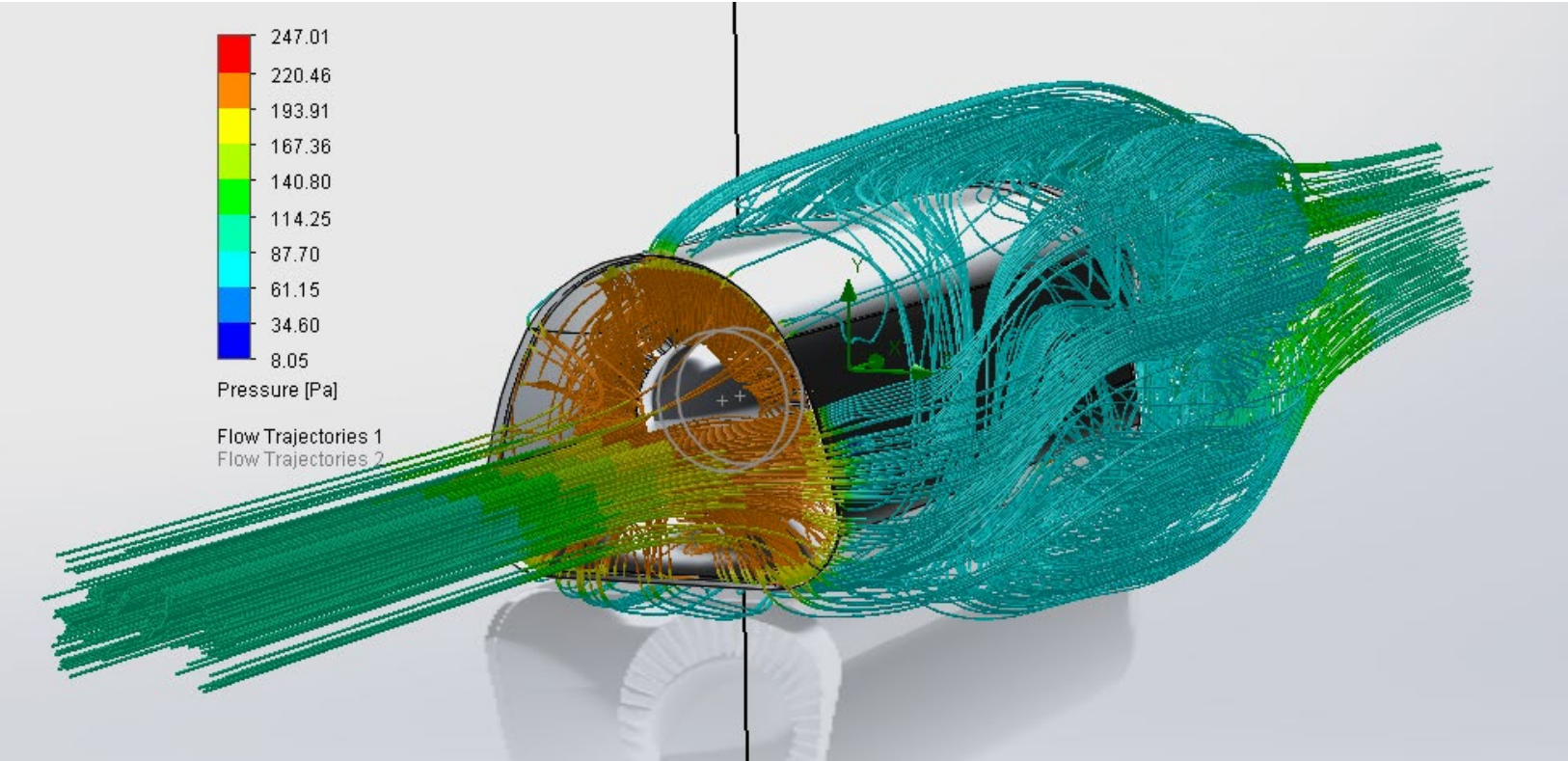
Example of Possible Air Flow

AIR, MASS, AND POWER ACCOUNTING

Mass Accounting:

Our capsule consists of variable parts as shown in the table. Each part has different mass and materials that is related with safety or center of mass. Each part of materials was set as the most proper properties. Especially 6061 T6 Alloy Aluminum has a properties that is light and very strong at the same time, so it used for many products such as air plane od space ship.

Name of components	Mass (lbs)	Amount	Material
Air ski	18.29	4	6061 T6 Alloy Aluminum
Air sleeve	541.926	1	6061 T6 Alloy Aluminum
Folding and vacuum sealant	1075.232	2	304L Stainless Steel
Ring motor	500	1	304L Stainless Steel
8-stage Compressor	725	1	6061 T6 Alloy Aluminum
Wheels	4.98	16	Natural rubber
disc brake components	2.04	16	Alloy Aluminum, and Magnesium
Batteries and casing for batteries	0.41	7	Lithium, and Aluminum
Nose cone	48.883	1	6061 T6 Alloy Aluminum
Tail cone	70.378	1	6061 T6 Alloy Aluminum
Turbine	42.979	1	6061 T6 Alloy Aluminum



Flow Trajectory of the Zeus-Typhon Capsule

Power Accounting:

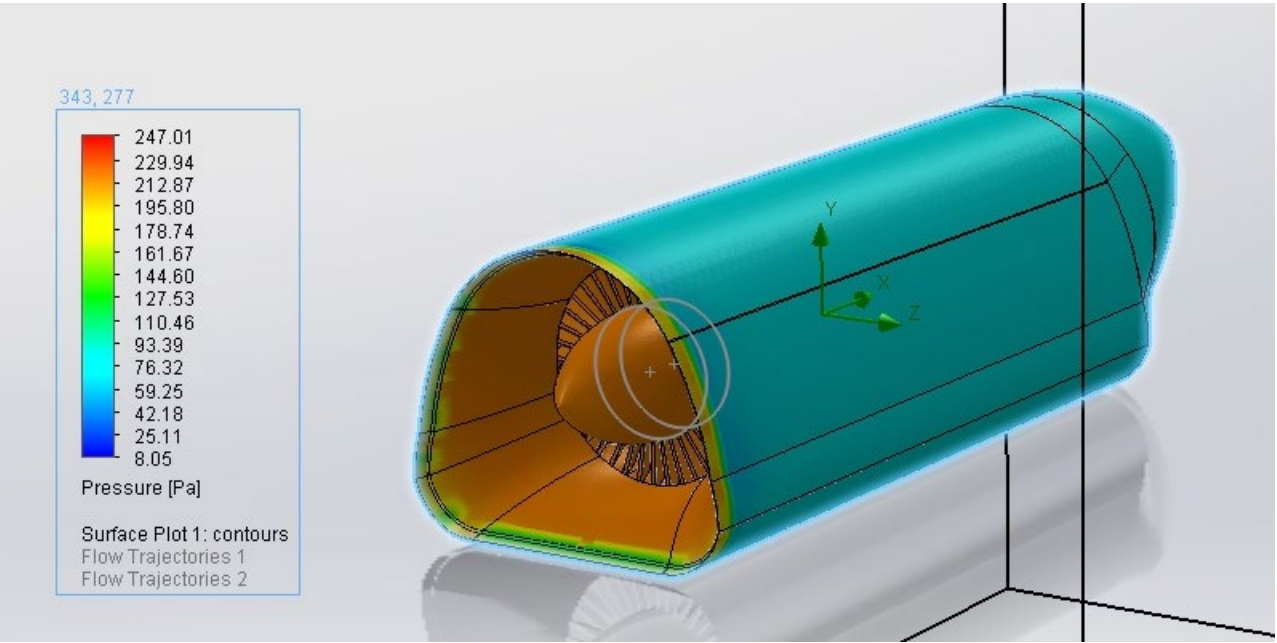
Estimated Competition Power Requirements	
Subsystem	Power Requirements
Compression and Electric Motor	39,000 W
Navigation and Communications	30 W
Processing	12 W

Air Accounting:

The power requirements of the arduino, Logger, accelerometer, color sensors, and the access point units draw an estimated 42 watts to accomplish navigating through the pod and communicating information such as distance in pod, velocity, acceleration, and speed instantaneously.

The power usage of the pod is predominantly from the compressor and electrical motor subsystem to continually draw in and compress air for the levitation system.

* 80% of total air bypassed for test ** 90% of total air bypassed at full scale



Flow Surface Plot of the Zeus-Typhon Capsule

Mission Profile

Description and Unique Features of the Capsule:

1. Our capsule has an air sleeve that allows for air to flow in through the front, compresses it in the ring motors that are within the air sleeve, that flows to exhaust and out the air skis.
2. We have an air folding system that allows for snug fit between the passenger cabin and air sleeve.
3. We are using something different than the standard fan that many of our competitors might have, and that is that we are using ring motors to pull air through the front end of the air sleeve to dispersal through the rear and out the air skis.
4. We have included into our design a junction between the rotor and stator.
5. Another thing that is unique about our pod is the way passenger loading occurs, which is to access the seats while the passenger pod is outside of the air sleeve by opening the back door hatch of the pod and loading passengers with the comfort of loading in open space and not while within the pod, which would pose a threat to human comfort.

Pod-Handling Safety:

1. The pod has air skis with wheels at the bottom in the case that the pod does not maintain the best distance from the tube at all points in the tube for the duration of the trip to ensure that in this case that the pod does not scrape at the bottom or slide on the bottom. This way even if we do not get the roughly 1-2 mm of distance between the tube and the capsule that we have this back up plan for ease of mind and comfort as the pod goes through the tube.
2. We also have a wheel deployment system in place in the case that the air skis fail to give the roughly 1-2 mm gap between tube and capsule as well as if they shut down or unexpectedly leak. The wheels will deploy from the inerts of the pod as soon as depressurization occurs within the air skis using a sensor for pressure in the air ski. We can also deploy the wheels manually via accessing the arduinos on board of the capsule through using the wifi provided by SpaceX in the competition.

Our pod will be hooked up to both the Hyperloop Power Umbilical and the Mechanical Propulsion Interface provided by SpaceX.

Zeus-Typhon Mission Profile						
		POD Subsystem States				
Mission Phase	Description	Wheels	Brakes	Main Compressor	Skis	Communications
Functional Test A	POD Power On Checks	Self Test	Self Test	Self Test	Self Test	Online, Direct Link
POD Load	POD being loaded into Tube	Deployed	Free/Ready	Powered Down	No Lift	Online, Direct Link
POD Connect	POD connected to Tube Propulsion Interface	Deployed	External Command	Powered Down	No Lift	Online, Direct Link
Functional Test B	POD Hover Test	Stowed	Hold Wheels	Powered Down	Lift, Air from Storage	Online, Direct Link
Functional Text C	POD Communication Test	Stowed	Hold Wheels	Powered Down	Lift, Air from Storage	Online, Tube Link
Tube Vac Down	Tube is Depressurised	Stowed	Hold Wheels	Powered Down	Lift, Air from Storage	Online, Tube Link
Pre-Launch	POD Systems initiated to Flight Read	Stowed	Hold Wheels	Powered Down	Lift, Air from Storage	Online, Tube Link
Compressor Power Up	Main Compressor transition to operating RPM	Stowed	Hold Wheels	Powering Up	Lift, Air from Storage	Online, Tube Link
Ready to Launch	All Systems Ready for Acceleration	Stowed	Hold Wheels	Powered Up	Lift, Via PCS	Online, Tube Link
Acceleration	POD is accelerated by Tube Propulsion Interface	Stowed	Hold Wheels	Powered Up	Lift, Via PCS	Online, Tube Link
Detach	POD is realeased from Tube Propulsion Interface	Stowed	Hold Wheels	Powered Up	Lift, Via PCS	Online, Tube Link
Cruise	POD moving freely through Tube	Stowed	Hold Wheels	Powered Up	Lift, Via PCS	Online, Tube Link
Deceleration	POD Decelerated Indepently of Tube Systems	Deployed	Modulate Wheels	Coast	Lift, Air from Storage	Online, Tube Link
Stop in Holding Area	POD Stopped in Holding Area	Deployed	Hold Wheels	Coast/Stopped	No Lift	Online, Tube Link
Tube Repressurize	Tube is Repressurised	Deployed	Hold Wheels	Stopped	No Lift	Online, Tube Link
Functional Test E	POD Safety to verify condition of POD	Deployed	Hold Wheels	Stopped	No Lift	Online, Tube Link
POD Transition to Exit	POD Transition to Exit Area	Deployed	Free/Ready	Stopped	No Lift	Online, Direct Link

Nose Cone

Team Zeus-Typhon Nose Cone Structure

Coming to the conclusion of which nose cone to choose came down to choosing the nose cone that has been known to propogate the least amount of drag since the nose cone was theorized in 1947. Thus, we used the Haack-Series nose cone to limitize the amount of drag that our capsule experiences during travel.

Equations

$$\theta = \arccos\left(1 - \frac{2x}{L}\right)$$
$$y(\theta) = -\frac{R}{\sqrt{\pi}} \sqrt{\theta - \frac{\sin(2\theta)}{2} + \frac{2}{3}\sin^3(\theta)}$$
$$y = \left(\frac{3.75\text{ft}}{2}\right) \sqrt{\arccos\left(1 - \frac{2x}{L}\right) - \frac{\sin\left(2\arccos\left(1 - \frac{2x}{L}\right)\right)}{2} + \frac{2}{3}\sin^3\left(\arccos\left(1 - \frac{2x}{L}\right)\right)}$$

, where L varies between 2 ft to 5.6 ft.

Nose Length Analysis:

In the following analysis, I created twenty-four different noses ranging from length 1-ft to 5.6-ft by incrementing by 0.2-ft per nose design. The following is my MATLAB program with the von Kármán equation evaluated twenty-four different times for each nose length.

```
Program:
clc, clear
% Nose_Cone_Shape_Calculator.m
%
% In this program I made an array of varying length's
from
% 1-ft to 5.6-ft, and increment by 0.2-ft to find equa-
tions
% for different nose cone lengths, and they have also
been
% graphed, and saved as a .jpg file under
% Desktop>>Hyperloop>>Hyperloop Nose Design.
%
% base_width=[3.5]; %ft
% max_width=[4.5]; %ft
% max_height=[3.75]; %ft
% total_length=[14]; %ft
len_var=1:0.2:5.6 %ft
% len_daniel=7;
syms x L;
```

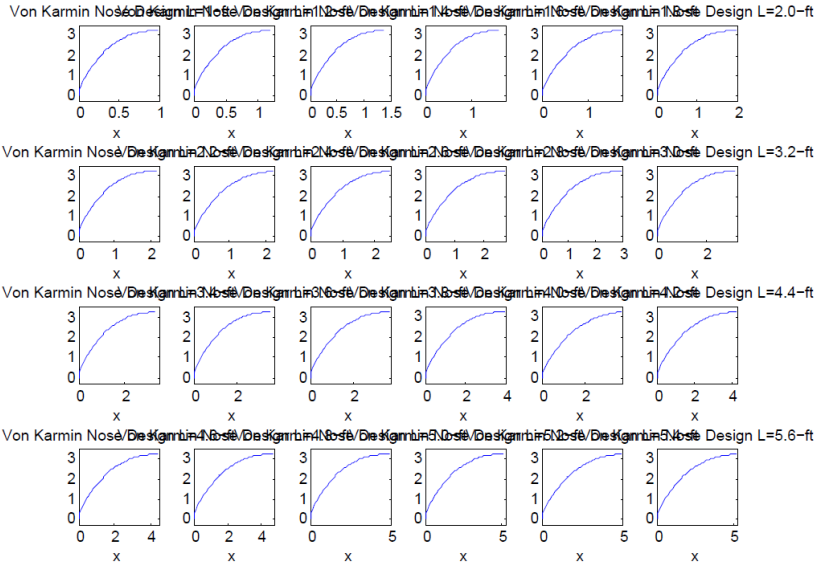
```
theta=sym('acos(1-(2*x)/L)')
y=(3.75/2-0.5)./sqrt(pi).*sqrt(theta-sin(2.*t
heta)/2+(2/3).*(sin(theta)).^3) %ft
% format long --- done separately
% y_solve_subs=subs(y,[L],[6])
% ezplot(y_solve_subs)
% y_solve_do_it=double(subs(y,[x-
,L],[2,6]))
y_solve_1=subs(y,[L],[len_var(1)])
y_solve_2=subs(y,[L],[len_var(2)])
y_solve_3=subs(y,[L],[len_var(3)])
y_solve_4=subs(y,[L],[len_var(4)])
y_solve_5=subs(y,[L],[len_var(5)])
y_solve_6=subs(y,[L],[len_var(6)])
y_solve_7=subs(y,[L],[len_var(7)])
y_solve_8=subs(y,[L],[len_var(8)])
y_solve_9=subs(y,[L],[len_var(9)])
y_solve_10=subs(y,[L],[len_var(10)])
y_solve_11=subs(y,[L],[len_var(11)])
y_solve_12=subs(y,[L],[len_var(12)])
y_solve_13=subs(y,[L],[len_var(13)])
y_solve_14=subs(y,[L],[len_var(14)])
y_solve_15=subs(y,[L],[len_var(15)])
y_solve_16=subs(y,[L],[len_var(16)])
y_solve_17=subs(y,[L],[len_var(17)])
y_solve_18=subs(y,[L],[len_var(18)])
y_solve_19=subs(y,[L],[len_var(19)])
y_solve_20=subs(y,[L],[len_var(20)])
y_solve_21=subs(y,[L],[len_var(21)])
y_solve_22=subs(y,[L],[len_var(22)])
y_solve_23=subs(y,[L],[len_var(23)])
y_solve_24=subs(y,[L],[len_var(24)])
% y_solve_len_daniel=subs(y,[L],[len_
daniel])
% ezplot(y_solve_len_daniel) ---- this
was to get a 7-ft Von Karman Nose
% ---- Cone that was
done separately
%
% title('Von Karman Nose Design L=7-ft')
% subplot(4,6,1)
ezplot(y_solve_1)
title('Von Karmin Nose Design L=1-ft')
subplot(4,6,2)
ezplot(y_solve_2)
title('Von Karmin Nose Design L=1.2-ft')
subplot(4,6,3)
ezplot(y_solve_3)
title('Von Karmin Nose Design L=1.4-ft')
subplot(4,6,4)
```

```
ezplot(y_solve_4)
title('Von Karmin Nose Design L=1.6-ft')
subplot(4,6,5)
ezplot(y_solve_5)
title('Von Karmin Nose Design L=1.8-ft')
subplot(4,6,6)
ezplot(y_solve_6)
title('Von Karmin Nose Design L=2.0-ft')
subplot(4,6,7)
ezplot(y_solve_7)
title('Von Karmin Nose Design L=2.2-ft')
subplot(4,6,8)
ezplot(y_solve_8)
title('Von Karmin Nose Design L=2.4-ft')
subplot(4,6,9)
ezplot(y_solve_9)
title('Von Karmin Nose Design L=2.6-ft')
subplot(4,6,10)
ezplot(y_solve_10)
title('Von Karmin Nose Design L=2.8-ft')
subplot(4,6,11)
ezplot(y_solve_11)
title('Von Karmin Nose Design L=3.0-ft')
subplot(4,6,12)
ezplot(y_solve_12)
title('Von Karmin Nose Design L=3.2-ft')
subplot(4,6,13)
ezplot(y_solve_13)
title('Von Karmin Nose Design L=3.4-ft')
subplot(4,6,14)
ezplot(y_solve_14)
title('Von Karmin Nose Design L=3.6-ft')
subplot(4,6,15)
ezplot(y_solve_15)
title('Von Karmin Nose Design L=3.8-ft')
subplot(4,6,16)
ezplot(y_solve_16)
title('Von Karmin Nose Design L=4.0-ft')
subplot(4,6,17)
ezplot(y_solve_17)
title('Von Karmin Nose Design L=4.2-ft')
subplot(4,6,18)
ezplot(y_solve_18)
title('Von Karmin Nose Design L=4.4-ft')
subplot(4,6,19)
ezplot(y_solve_19)
title('Von Karmin Nose Design L=4.6-ft')
subplot(4,6,20)
ezplot(y_solve_20)
title('Von Karmin Nose Design L=4.8-ft')
```

```
subplot(4,6,21)
ezplot(y_solve_21)
title('Von Karmin Nose Design L=5.0-
ft')
subplot(4,6,22)
ezplot(y_solve_22)
title('Von Karmin Nose Design L=5.2-
```

```
ft')
subplot(4,6,23)
ezplot(y_solve_23)
title('Von Karmin Nose Design L=5.4-ft')
subplot(4,6,24)
ezplot(y_solve_24)
title('Von Karmin Nose Design L=5.6-ft')
```

Graph (1) (Below):
Nose Cone Graphs
Ranging in Length
from 1-ft to 5.6-ft by
0.2-ft increments

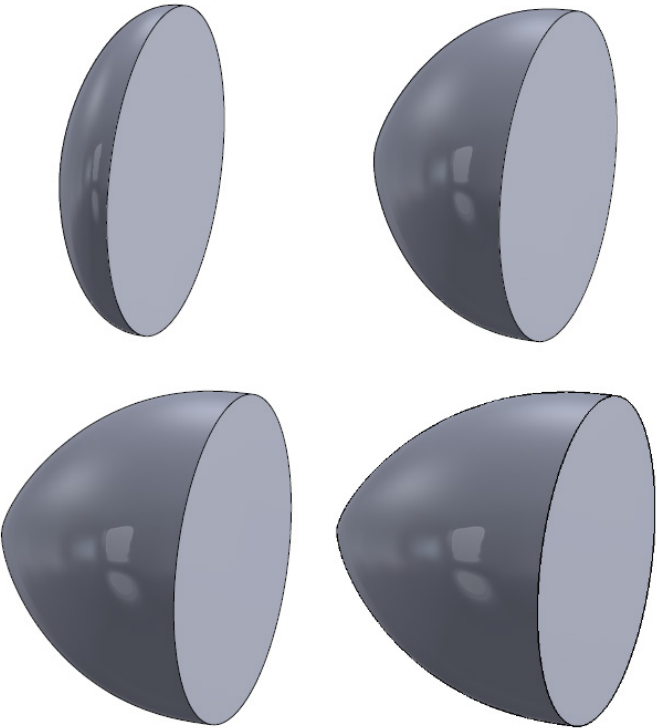


Example of an equation generated by the von Kármán Nose Equation:

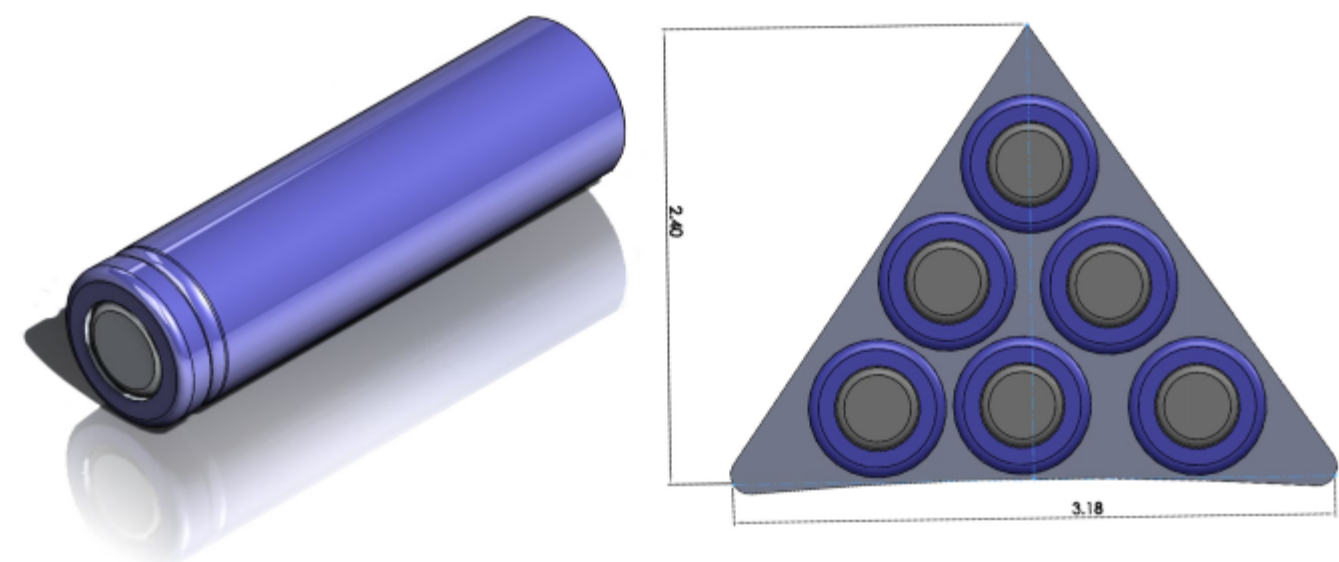
```
% y_solve_1 =
%
% (6987430995137975*(acos(1 - 2*x) - sin(2*acos(1 - 2*x)))/2 + (2*(1 - (2*x - 1)^
2)^(3/2))/3)^(1/2))/9007199254740992
```

Figure (1):
Four Different Sized Nose
Cones

Based off of the von Kármán nose cone equation and through a MATLAB program that calculated 24 different nose cones. We found 24 different nose cone equations for the radius and then revolved this in Solidworks to form the cone. To the right are four out of the twenty four nose cones length, respectively (ft): 2, 3.8, 4.8, and 5.4.

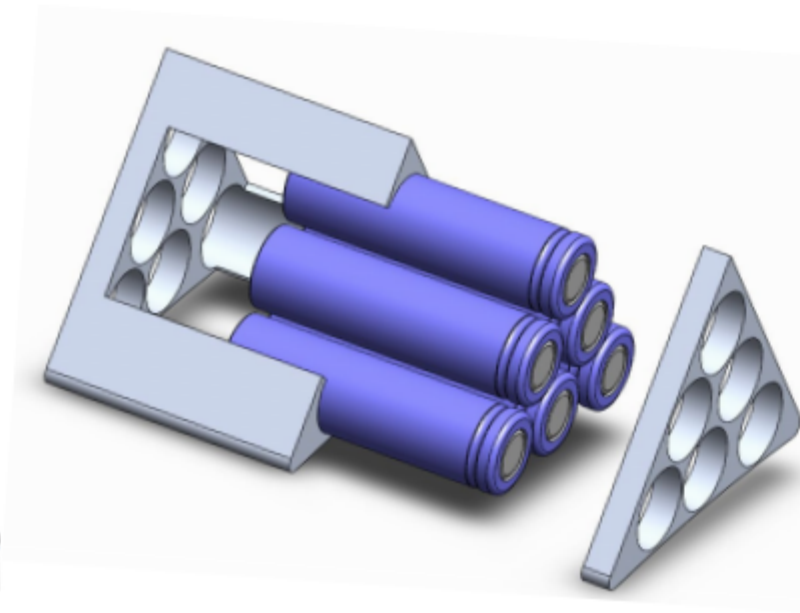


BATTERY SYSTEM



Single Battery

Triangular Battery Case Dimensions



Exploded View Battery

The battery system consists of batteries fitted into a triangular prism. The material of the container is aluminum. This geometry allows the prisms to be fitted into the folded structural system of the pod. The battery packs will utilize commercial lithium ion cells, which can deliver up to 4.2 volts at 2700 mAh. From initial power requirement analysis of the 1 mile competition objective, we determined that 25 lithium ion cells, in series, will satisfy our needs. The battery packs are modular, so that we may fit more into packs to accommodate new components in future designs, and that they may be replaced with ease.

The following is a calculation for a battery system that is required to accommodate the compressor, which is the predominant system that requires power.

Ohm's law gives:
 $P=IV$

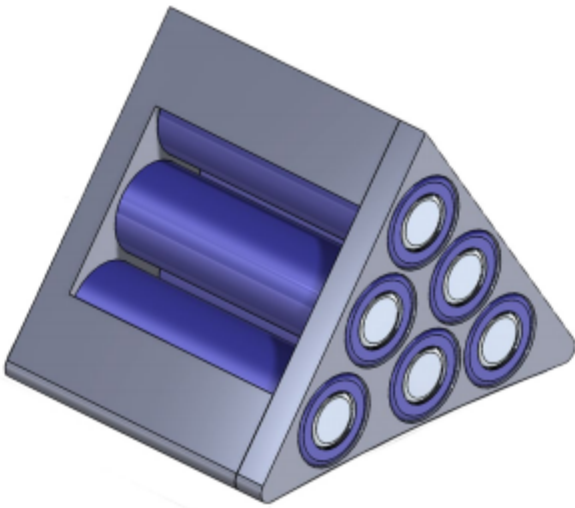
We utilize a 100 volt power bus, we've estimated the power required, the trip time, and thus the amount of amp-hours is calculated: $\approx 1.9 \text{ Ah}$

Ideal Work = $-(P1)(V1)\ln(P2/P1)$ [lb in]		In Joules:
[W1]	4185958.924	472949.8365
Work to Compress = Ideal/efficiency [lb in]		
[Wc]	5232448.655	591187.2956
Work required by Electric Motor = (Work to Compress)/(Motor Efficiency) [lb in]		
[We]	6155821.947	695514.4654

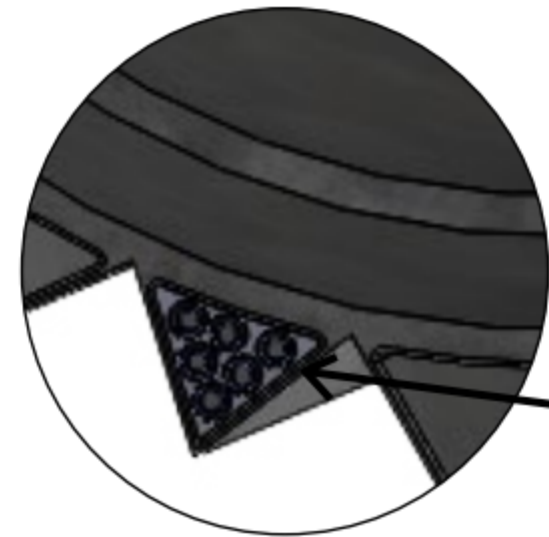
P1(psi)	Crosssectional Area of Pod (in^2)	Volume of air ingested per mile(in^3)
0.0145038	1520.53	96340780.8
Compressor Efficiency	Electrical Motor Efficiency	
0.8	0.85	

1 MILE ANALYSIS		
Distance [mile]	Average Speed [mph]	Time = (Distance)/(Speed) [seconds]
1	200	18
Power = (Energy/seconds) [Watts]	[Horsepower]	
38639.69252	51.81660047	
1 MILE HEAT ANALYSIS		
Heat Waste from Compressor [lb in]		In joules:
Qcomp = (1 - Compressor Efficiency)(Ideal Work)	837191.7848	94589.96729
Qmotor = (1 - Motor Efficiency)(Work to Compress)	784867.2982	88678.09434
Total Q = Qcomp + Qmotor	1622059.083	183268.0616
1 MILE ENERGY ANALYSIS		
Voltage	Current [Amps] = (Power)/(Voltage)	Li-Ion Cell Specifications
100	386.3969252	Voltage
		4.2
		Rated Capacity [Amps]
		2.7
Minimum Battery Storage [amp-hours]	Minimum Required Cells in Serial Connection	
1.931984626	23.80952381	
Minimum Cells in Parallel		
1		

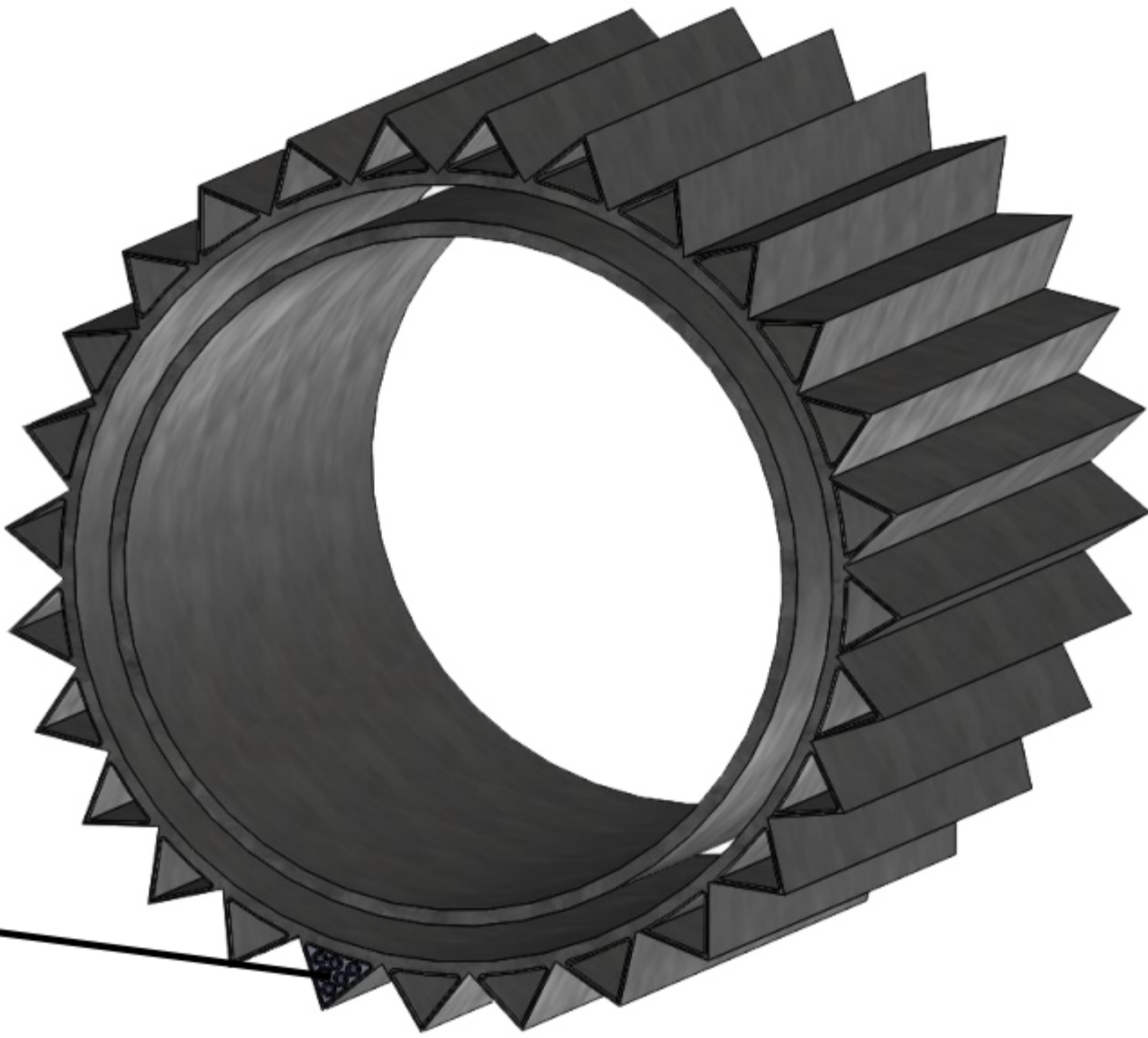
Power Heat Analysis



Triangular Battery Case Pack



Detail View of Battery Pack



Battery Pack into Folding Assembly

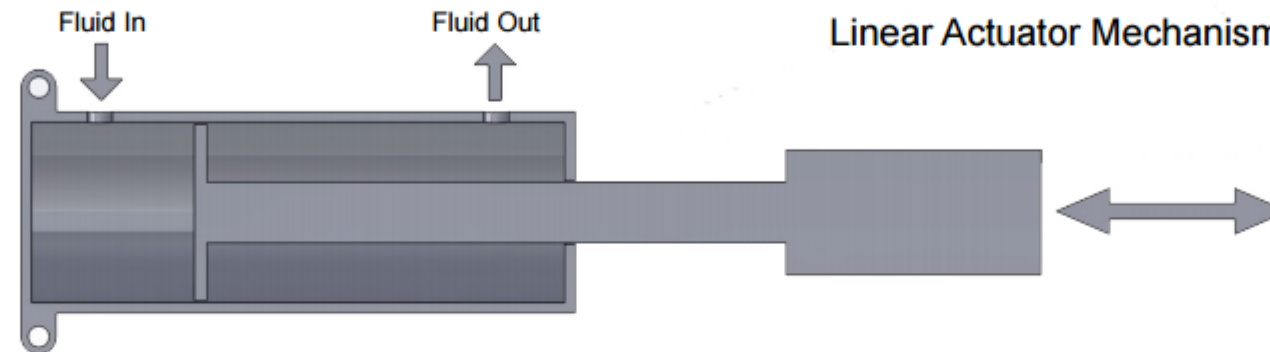
POD STABILITY MECHANISM

Keeping the pod stable is a major concern. The pod has a potential of three axes of travel and a corresponding three types of rotation; pitch, roll, and yaw. If these three types of motion were to happen in an uncontrolled environment, the results could range from minor passenger discomfort to the complete destruction of the pod. As such, multiple systems will be implemented to combat these three types of rotation.

- Pitch occurs when there is a net torque exerted on either the front-end or rear-end of the craft.
- Roll occurs when there is a net torque exerted about the longitudinal axis of the craft.
- Yaw occurs when there is a net torque exerted about the craft's normal axis, similar to the motion of a spinning top.
- In this case, our main concern is preventing roll.

Linear Actuator

- This mechanism would be used to combat the effects of a net rolling force.
- The main up-side of this mechanism is that it could be adjusted mid-trip.
- Would consist of a piston with a weighted mass on the end of an extendable arm.
- To increase torque, the piston would extend the weight. The farther out the weight is extended, the greater the torque produced.
- This device would allow the pod to maintain its normal orientation while facing weak to strong rotational forces.
- Linear actuators come in both electric and pneumatic versions and in a variety of different sizes.



Mass Distribution

- This system would be used to combat all rotational forces acting on the pod.
- This would understandably be unadjustable during the duration of the trip, but would act as a solid basis upon which to add other control mechanisms.
- A pod utilizing this method would display several features.
 - ◊ It would have a low center of gravity, with much of the machinery and overall mass located below the pod's centerline.
 - ◊ The cross-section would ideally be non-circular in shape.
 - ◊ Much of the mass would be concentrated at the ends of the pod.
 - ◊ The remaining mass would be fairly evenly distributed along the length of the pod.

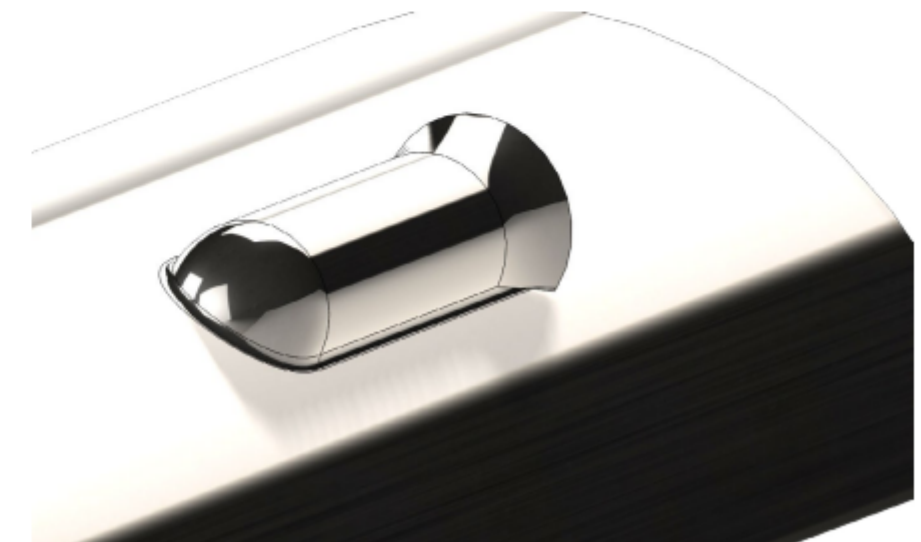
Shock Absorbers

- Shock absorbers would comprise our main method of combating sudden pitches and yaws.
- The absorbers would be located in between the air skis and their respective outriggers.
- There are a wide variety, ranging from simple spring designs found in cars to pneumatic designs to air-based systems.
- In addition to the main shock absorbers, the air skis themselves would provide a nominal amount of shock-absorbance. They operate in a similar manner as the air-based shock absorption systems.
- This system is often a static one, but some amount of fine-tuning could be done mid-trip.
- This system would be used to combat both pitch and yaw acting upon the pod.
- It would be a static system and would not be adjustable during the trip.
- This method involves shaping the outer mold line of the pod in such a way as to use aerodynamic forces acting upon the pod to increase the pitch angle of the pod or to help center the pod in the tube.
- This method works in tandem with an even mass distribution to maintain an upright, laterally stable pod.
- A highly-streamlined outer mold line minimizes the amount of buffeting due to aerodynamic forces.

Body Design

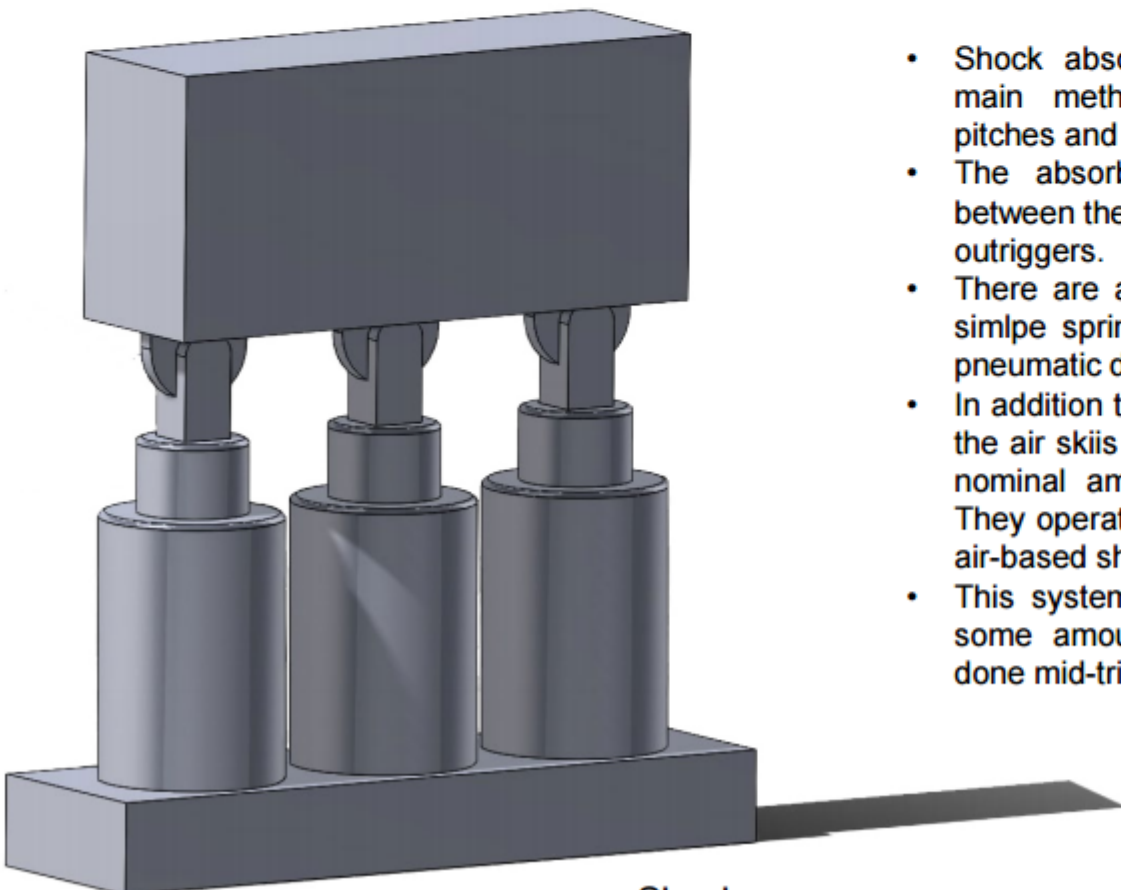
Air Jets

- This mechanism would be used to combat the effects of a net rolling force.
- Air jets would be used either to provide a short burst of torque to combat a sudden roll-increase or to provide constant torque to combat a system failure.
- The air jets in mind would be similar to the ones aboard spacecraft.
- Air could be gathered from the exhaust system and compressed to provide the fuel for this system.



Air Jet

Shocks



POD BRAKING MECHANISM

Our capsule use wheel disc system which is normally used for car or plane. Following Pascal's low, it is possible to transfer energy from pedal to the brakes. The braking system is consisted by wheel, brake caliper assembly, disc brake rotor and wheel hub assembly.

When we assume the deceleration is consistent, the capsule will stop after time t (s) passes. Since this, the force 1695000/t (N) acts in opposite direction of the direction capsule in motion to stop it. When the capsule brakes for emergency or a peak time, we assume the deceleration is a=-1g=-9.8 (m/s^2). Then it will take 34.6 seconds to stop the capsule and the braking distance is about 5863 meters. In this case, the force 49000 (N) needs to stop the capsule.

Where, the distance from CM to the wheels=0.920(m), The distance from CM to the ground=0.686(m), the net torque on the capsule should be zero to stop the capsule. In this case, the normal force of a front wheel is 35527 (N) and that of the rear wheel is 13473 (N). Since this, we can know that the force on the front tires is greater than on the rear tires from calculation. It means that the front tires wear out a lot faster, so the capsule are designed with larger brake pads on the front wheels that on the rear.

When the capsule brakes normally, it stops in 2minutes. In this case the capsul decelerate at rate of 0.288g. The force 14125(N) acts in opposite direction of the direction capsule in motion to stop it. If it takes 2 minutes to stop the pod capsule, the braking distance is 20340(m).



Deployed Wheels

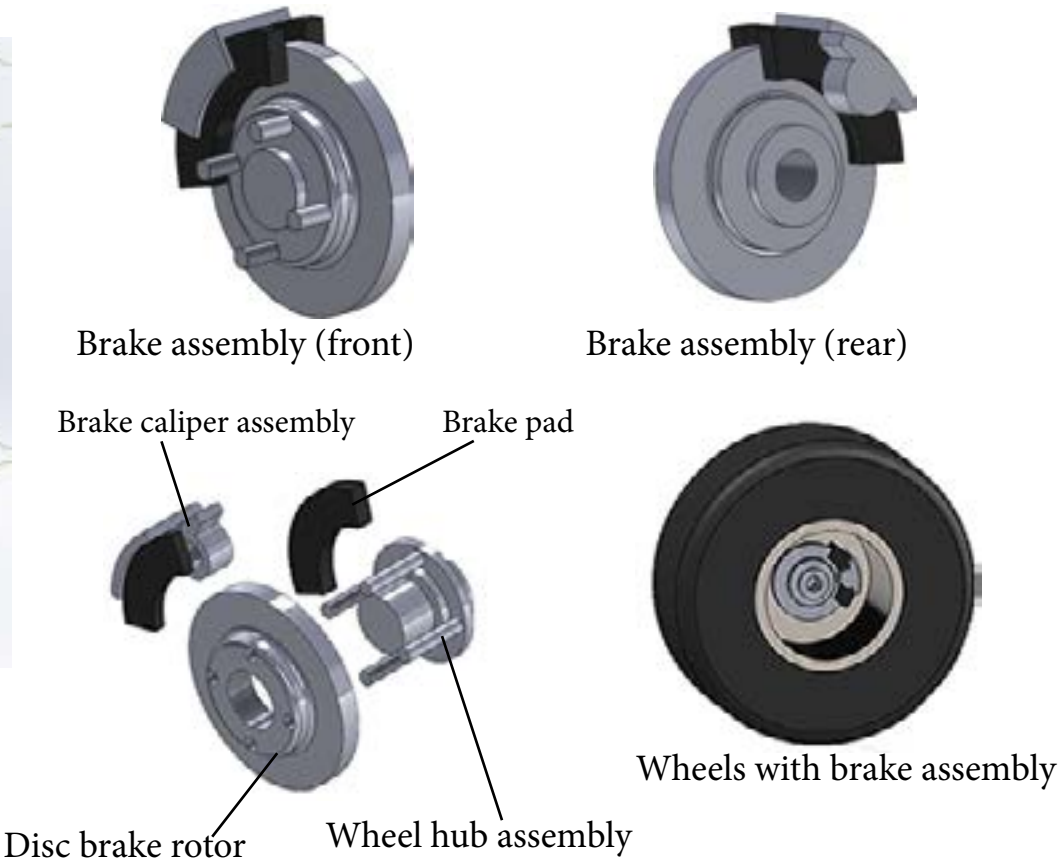
Wheel Material Wheel of Hyperloop should made from either aluminum or magnesium alloys. These materials provide a strong, lightweight wheel that requires very little maintenance. Aluminum and magnesium alloys have a high melting point so it can endure with high frictional force. In addition both of them is very light and hard than any other materials, so those materials are proper for Hyperloop which moves with very high velocity.



Center of Mass
1) Separated
 $x_{cm}=(m_1 x_1+m_2 x_2)/(m_1+m_2)$
 $m_1 r_1=m_2 r_2$
 $x_{cm}=\lim_{\Delta m \rightarrow 0} (\sum_{i=1} N(\Delta m_i x_i))/M=(\int_0 M(xdm))/M$
2) Continuous
 $x_{cm}=(\int_0 L(x*M/L dx))/M=L/2$
Assume that ...

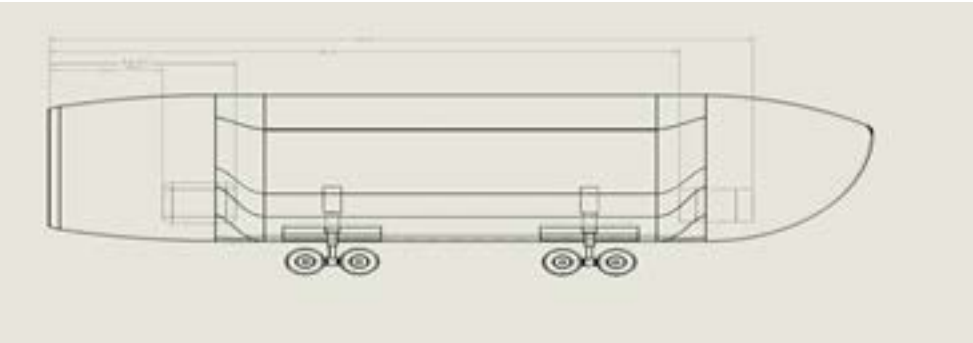
M (total mass of capsule) = 5,000 kg
 m_{water} = 500 kg
 m_{motor} = 140 kg
 $m_{batteries}$ = 1,000 kg
 $m_{10\text{ passengers+each chairs}}$ =1,000 kg
 $m_{main\ body}$ =2,360 kg
Height = 3.75 ft
Width = 4.5 ft
Base width = 3.5 ft
Length = 14 ft

So, for the Hyperloop for x-axis...
 $((m_{water} x_1)+(m_{motor} x_2)+(m_{batteries} x_3)+(m_{10\text{ passengers+each chairs}} x_3)+(m_{main\ body} x_3))/M$
 $=((500\text{ kg*1 m})+(140\text{ kg*0.5 m})+(1000\text{ kg*3.5 m})+(1000\text{ kg*2.1336 m})$
 $+ (2360\text{ kg*2.1336 m}))/ (5000\text{ kg})$
 $=2.2478\text{ m}\approx 7.3748\text{ ft}$
For y-axis...
 $((m_{left} x_1)+(m_{right} x_2))/M$
 $=((2500\text{ kg*0.3429 m})+(2500\text{ kg*1.0287 m}))/ (5000\text{ kg})$
 $=0.6858\text{ m}\approx 2.25\text{ ft}$
For z-axis...
 $((m_{floor} x_1)+(m_{top} x_2))/M$
 $=((3000\text{ kg*0.3})+(2000\text{ kg*0.9}))/ (5000\text{ kg})$
 $=0.54\text{ m}\approx 1.7717\text{ ft}$



In physics, the center of mass of a distribution of mass in space is the unique point where the weighted relative position of the distributed mass sums to zero or the point where if a force is applied causes it to move in direction of force without rotation. The distribution of mass is balanced around the center of mass and the average of the weighted position coordinates of the distributed mass defines its coordinates. In my Hyperloop,

- * The center of mass should be around at the middle point of the main body.
- * Center of mass of this capsule should not be very high, left-placed or front.
- * This center of mass can be placed of the range of 30% from the middle point.



THERMAL ACCOUNTING

What is air compressor?

There is an air compressor inside the pod for many uses. The type of compressor inside the pod is axial compressor. An axial compressor is a machine that can continuously pressurize gases. It is a rotating, airfoil- based compressor in which the gas or working fluid principally flows parallel to the axis of rotation. Axial flow compressors produce a continuous flow of compressed gas, and have the benefits of high efficiency and large mass flow rate, particularly in relation to their size and cross-section.

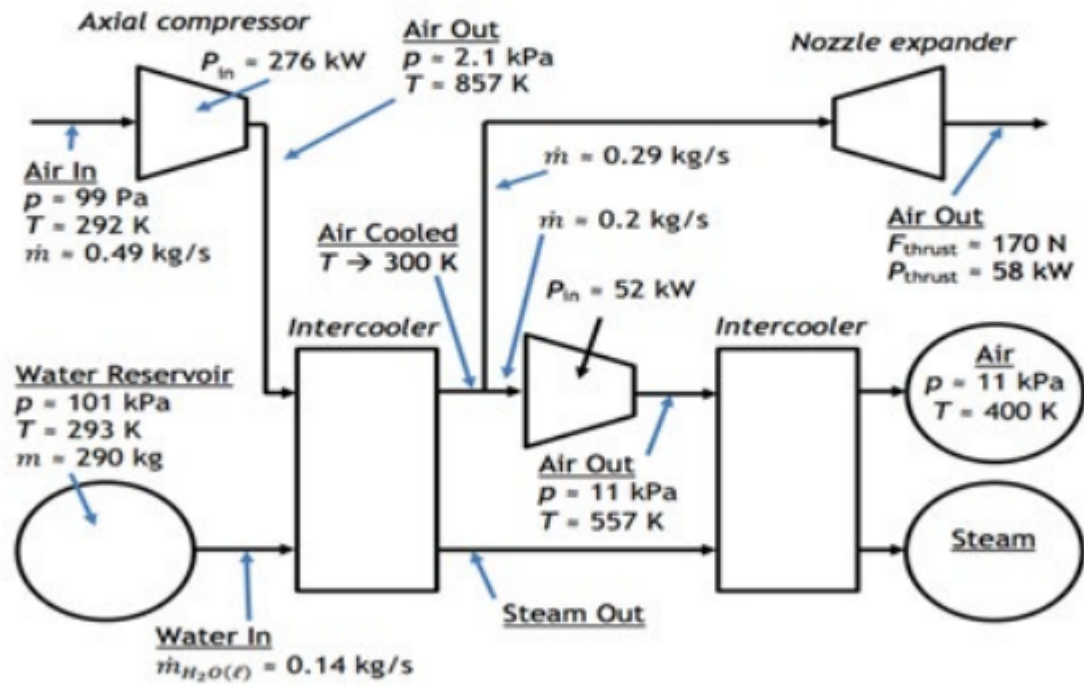
Heat produced by air compressor:

Based on the white paper, the power goes into the compressor is 808kW=808000 J/s . Assuming the time of travel is an hour and half, then the total power consumed by compressor will be

$$808000 \text{ J/s} \cdot 60 \text{ sec/min} \cdot 90 \text{ min} = 4363200 \text{ kJ}$$

The energy efficiency depends on the speed of air flow. The designed speed of pod is 0.99 Mach. We assume the efficiency of the compressor is 80% when pod is under transonic speed. Then make another assumption that all energy lost becomes heat, so the total heat produced by compressor will be

$$Q = 4363200 \text{ kJ} \cdot (1 - 80\%) = 87264 \text{ kJ}$$



Heat produced by air friction:

Heating is really only significant when you get a shock wave i.e. above the speed of sound. That's because above the speed of sound the air can't get out of the way fast enough so we get a shock wave at the front of the object. This shock wave increases the pressure and therefore compresses the gas and increases its temperature.

The sound barrier or sonic barrier is a popular term for the sudden increase in aerodynamics and other effects experienced by an aircraft or other object when it approaches supersonic speed. When aircraft first began to be able to reach close to supersonic speed, these effects were seen as constituting a barrier making supersonic speed very difficult or impossible.

In dry air at 20 °C (68 °F), the sound barrier is reached when an object moves at a speed of 343 meters per second (about 767 mph, 1234 km/h or 1,125 ft/s)

In our project, the air pressure inside the tube is significantly small and the designed speed is less than 1 mach. The air friction should be small in this case, but to have further analysis, more experiments need to be done.

Heat produced by human activity:

Assumptions: 28 passengers per pod, An hour and half travel time, 156 Cal energy emitted per passenger during the travel, Cross section area of the pod is 4.0 m², Length of pod is 15 m.

Then there will be a relation $\Delta E = m \cdot c \cdot \Delta T$,
 $\Delta E = 28 \cdot 156 \cdot 4184 \text{ J} = 1.225 \text{ kg/m}^3 \cdot 4.0 \text{ m}^2 \cdot 15 \text{ m} \cdot \Delta T$,

Then we have $\Delta T = 248649 \text{ }^\circ\text{C}$,
the total energy produced will be 18276 kJ.

What is water-cooling?

Water cooling is a method of heat removal from components and industrial equipment. As opposed to air cooling, water is used as the heat conductor. Water is inexpensive and non-toxic. The advantages of using water cooling over air cooling include water's higher specific heat capacity, density, and thermal conductivity. This allows water to transmit heat over greater distances with much less volumetric flow and reduced temperature difference.

After mixing air and water, heat will transfer from high temperature air to low temperature water, thus increases the temperature of water. As water goes through the inside cycle, heat will goes out from the pod. In addition, the vaporization of water will also bring out a large amount of heat.

Energy into the system (compressor + water-cooling system) is:

$$(808000 + 60000) \text{ J/s} \cdot 60 \text{ sec/min} \cdot 90 \text{ min} \cdot 80\% = 3749760 \text{ kJ}$$

Total mass of air pass through the compressor is:

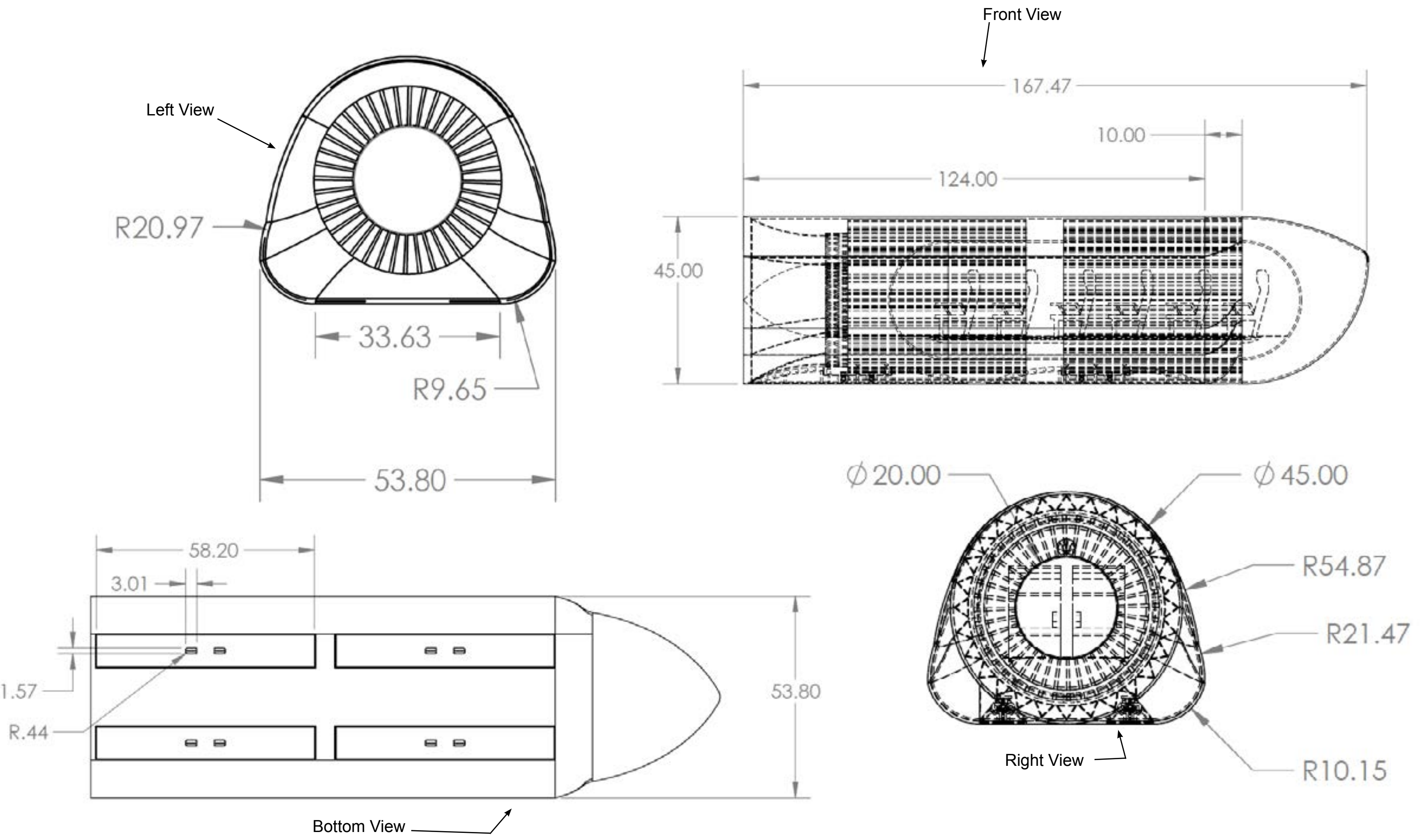
$$1.43 \text{ kg/s} \cdot 60 \text{ sec/min} \cdot 90 \text{ min} = 7722 \text{ kg}$$

Total Energy consumed by air (which increase its temperature) is:

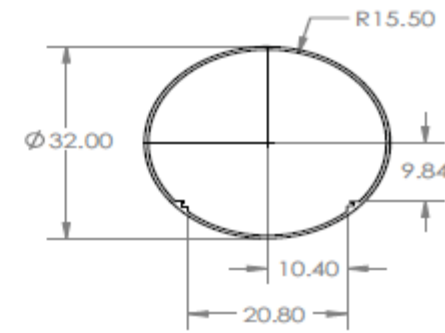
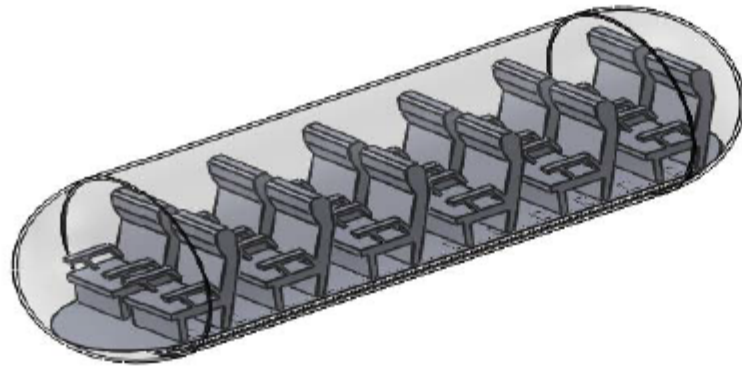
$$\Delta E = m \cdot c \cdot \Delta T = 7722 \text{ kg} \cdot 1005 \text{ J/(kg} \cdot \text{K)} \cdot (400 - 292) \text{ K} = 838145.88 \text{ kJ}$$

Energy absorbed in the water-cooling system during the travel will be
 $3749760 \text{ kJ} - 838145.88 \text{ kJ} = 2911614.12 \text{ kJ}$

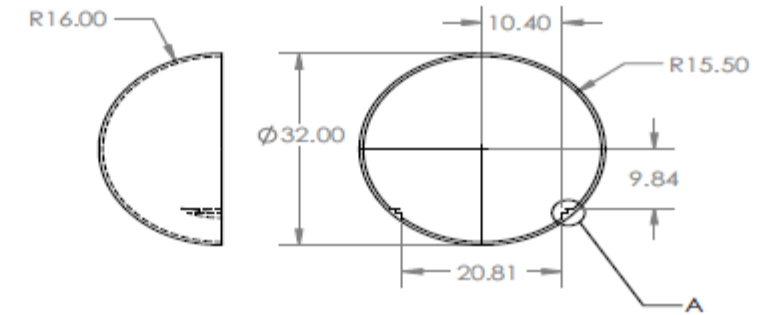
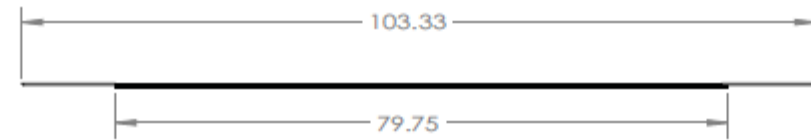
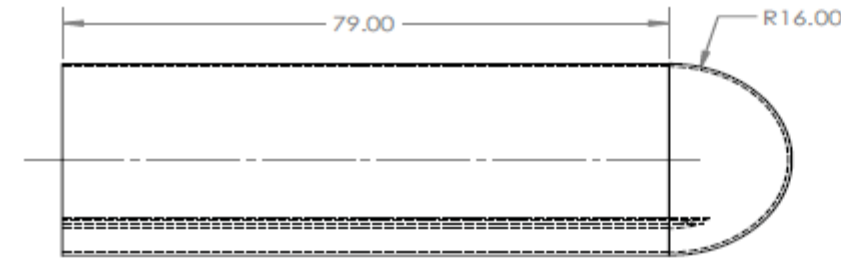
ESTIMATED POD DIMENSIONS



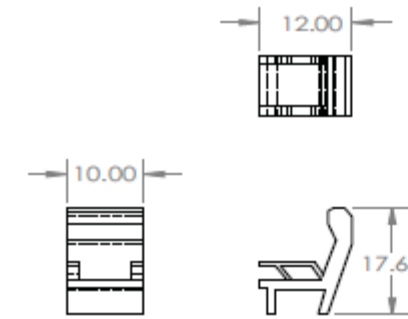
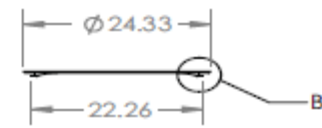
PASSENGER COMPARTMENT SPECIFICATIONS



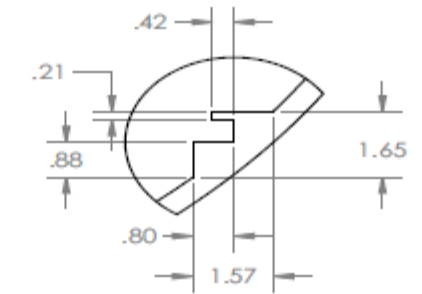
CAPSULE FRONT SECTION
FOR DETAIL USE DETAIL A



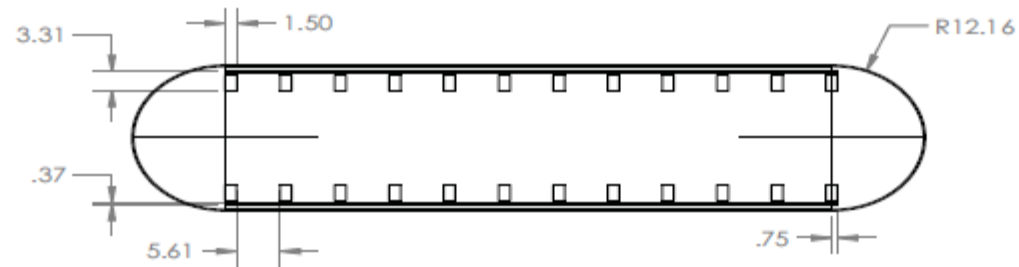
CAPSULE REAR SECTION



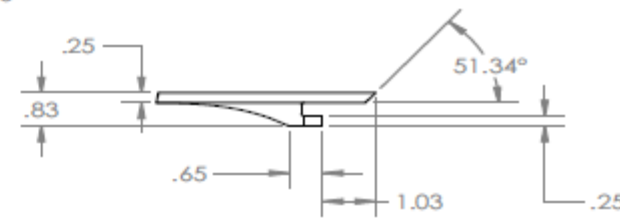
BASIC CHAIR



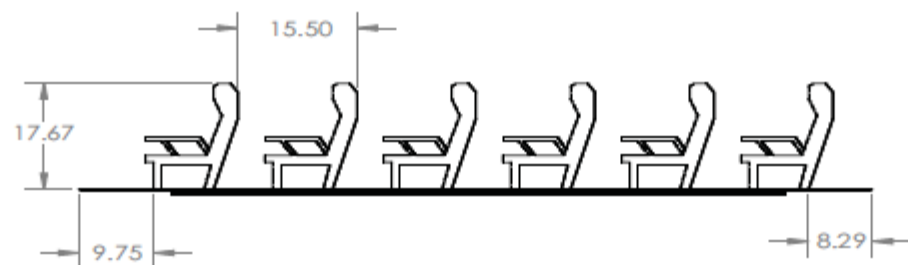
DETAIL A
SCALE 1 : 3



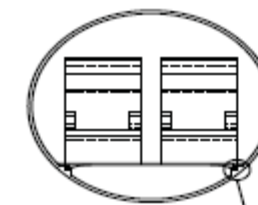
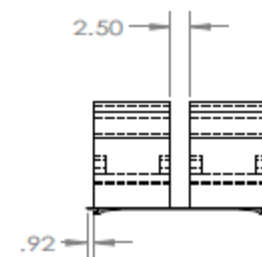
SLIDE TRAY



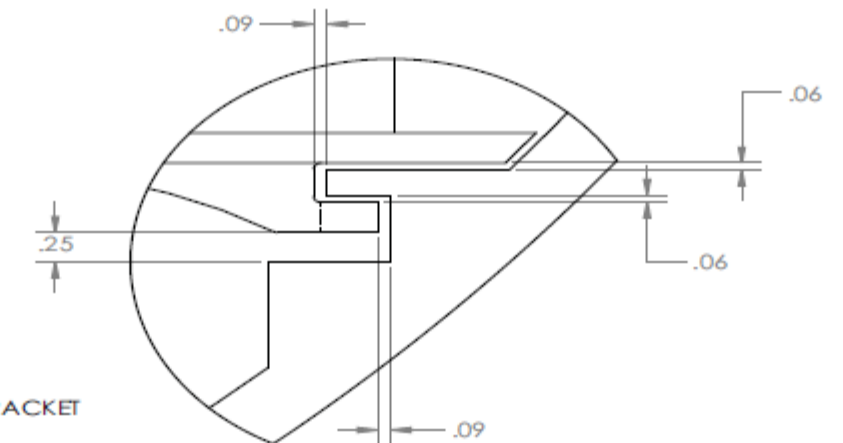
DETAIL B
SCALE 1 : 3



SEATS ON TRAY



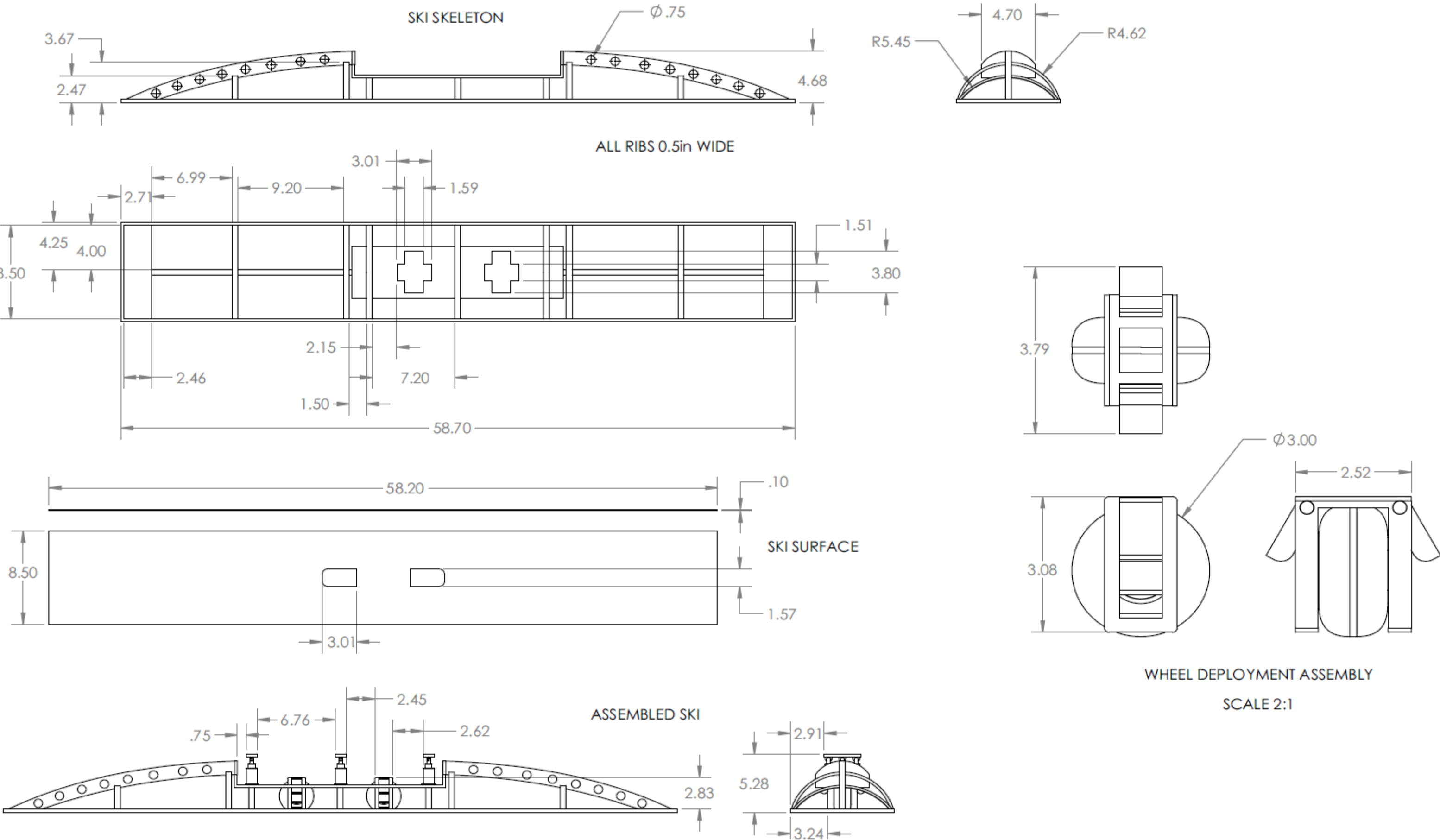
DETAIL OF BRACKET



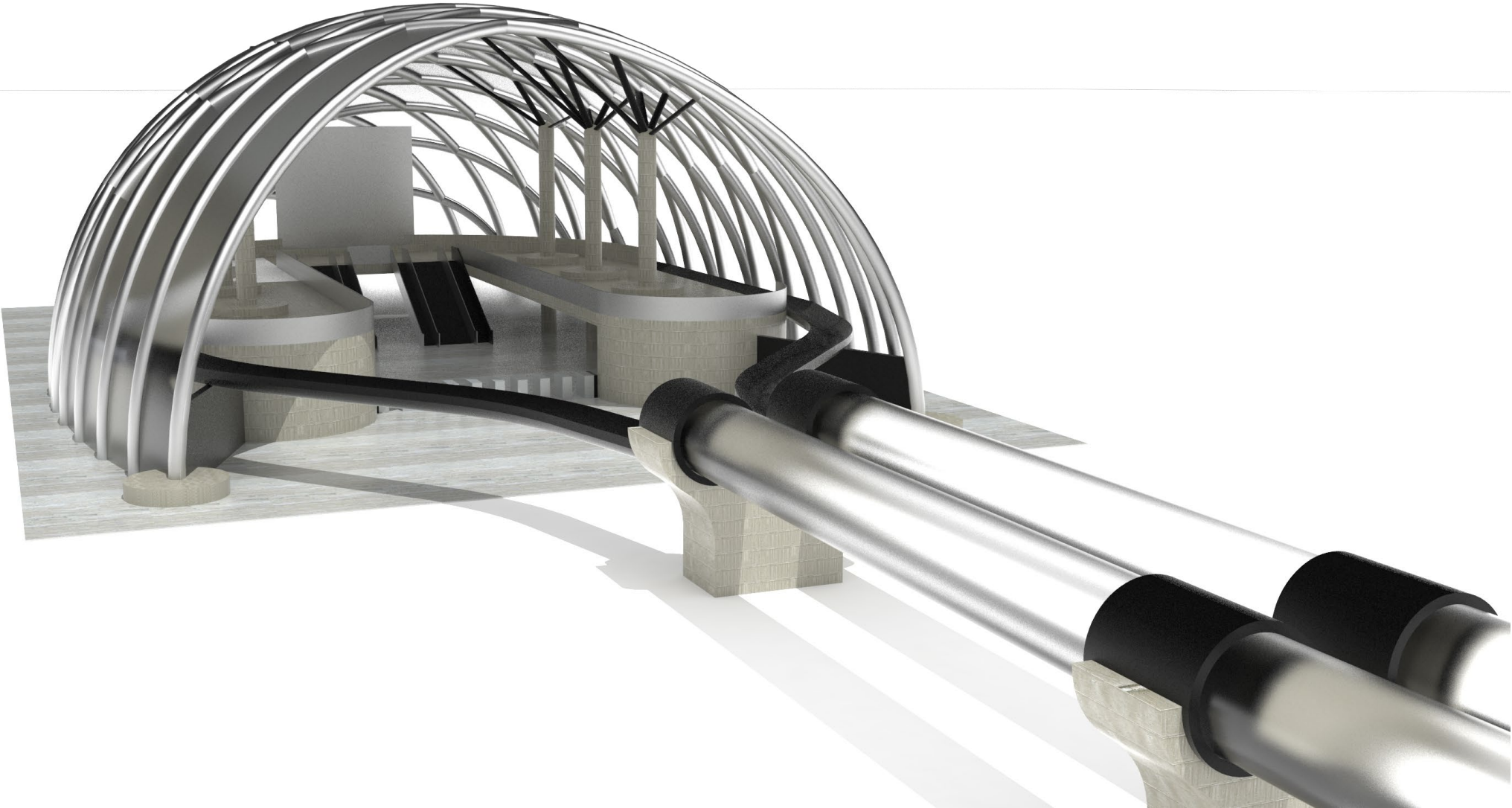
DETAIL C
SCALE 1 : 1

SHEET SCALE 1:20

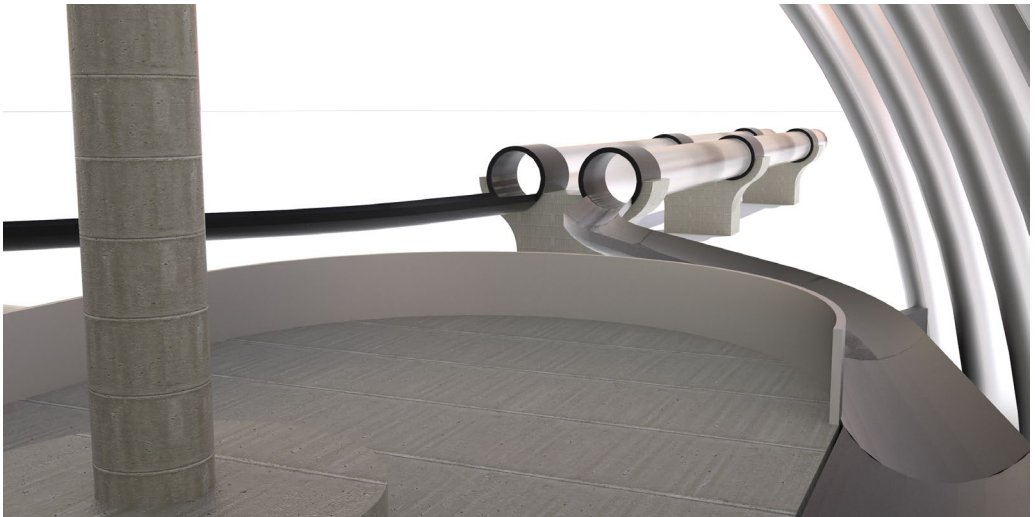
AIR SKI SPECIFICATIONS



HYPERLOOP STATION MOCK-UP



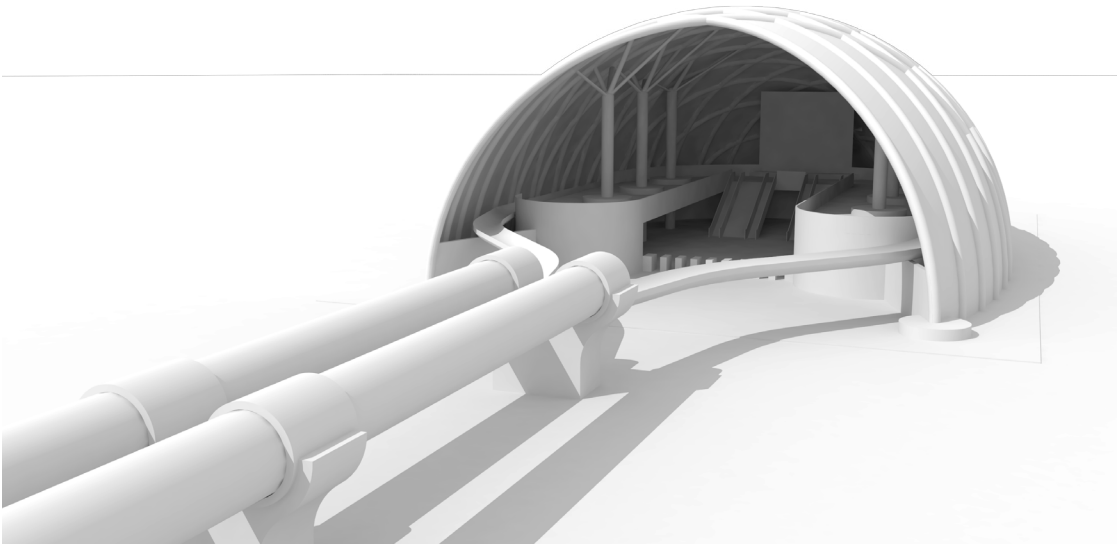
View of Hyperloop Station



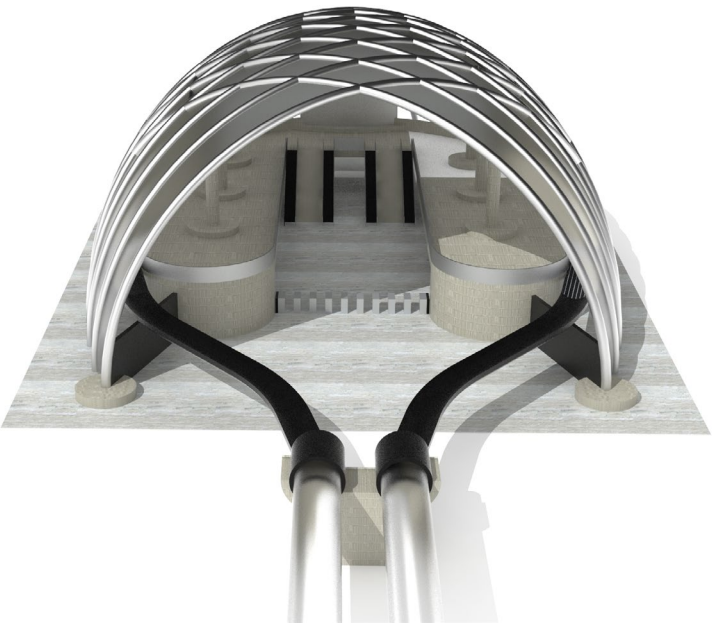
Passenger Loading Platform View



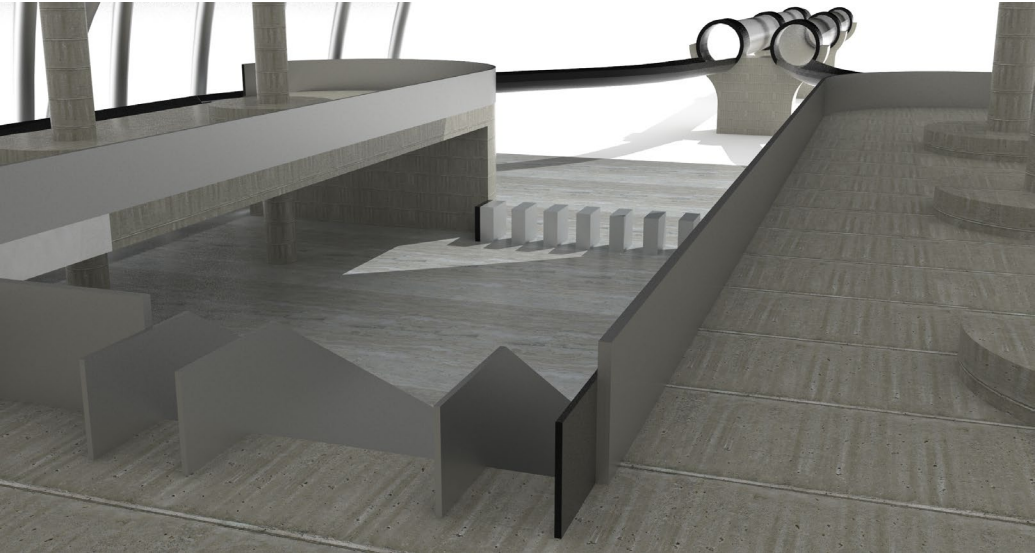
Station Entrance View



Perspective View of Hyperloop Station



Axonometric View of Station



Second Level Staion View

NOTES ON POD PROPULSION, NAVIGATION, COMMUNICATION, AND SAFETY

The Means of Propulsion:

1. Utilizing the Pusher
2. Utilizing Excess Air
3. Utilizing Wheel System

1. Our pod will utilize the SpaceX pusher as the main initial propulsion system, which will get the pod up to speed during the first 800 feet. Because the specification of the SpaceX Pusher is subject to change, the profile of the mechanical interface will also be flexible to accept these changes.

2. Throughout the trip, our pod will ingest excess air. The excess of which will be utilized by expanding it in a rearward facing thruster to counteract drag during the ride.

3. Our wheeled brakes will serve dual purposes as we intend to have motors on these wheels. This design choice is beneficial to support regenerative braking capabilities, and pod logistics outside of the tube.

Physics of the Braking Mechanism

While Navigating the Tube:

We will start to brake at a certain distance within the tube that we calculated before hand and that we can also make adjustments to when we start to decelerate based off of how fast we are actually going compared to our theoretical calculations of how fast we should be going based off our mass and our propulsion mechanism output. Applying the physics of our deceleration methods we will be able to determine theoretically before we get in the tube when we should stop braking exactly, but we will take into consideration that we will have uncertainty as to how much we are deviating from our theoretical speed. Accommodating for different possibilities might be the best option when determining what can go wrong in the tube and when. Calculating for inertia of our pod experimentally before we enter the pod, we then will have a better idea of how our pod will react within the tube. Also, doing simple tests onto alignment of the capsule and the deviation from our theoretical capsule we will be able to determine if we need to make adjustments to air ski output on either side at front or tail as well as make adjustments to our propulsion system prior to entering the tube.

Navigating Using Color Sensing & Arduinos:

Given the optical markings on the upper portion of the tube with standard unit circle angles from 0 radians to π radians on the inner dimensions of the tube. Team Zeus-Typhon will be reading the strips using a color sensor that we will hook up to an Arduino to be able to detect where we are in the tube based off the tape spacing and colors. The color sensor will transmit data of brightness of the strip of tape that is detected by the sensor, which the color sensor would have already been calibrated to measure the brightness of a certain color either the lime green or orange tape, and based off of those numerical values for brightness. Determine whether the tape is orange or lime green. Knowing this information we will know where we are in the capsule to allocate for what we have to do and when using a program to automatically and manually make adjustments as we go through the tube.

Emergency Braking System

As mentioned above, if anything were to happen to the traveling mechanism of the capsule such as an earthquake or a human related incident, the emergency brakes would open from its compartment underneath the air skis and will be carried out to the nearest station. The emergency brakes are located in each ski and would most likely consist of aircraft-grade tires inside of support brackets. These e-brakes are sufficient to carry out a broken pod because they can lock in the deployed position in case of pod power loss.

Capsule Depressurization

Although it would be highly unlikely for a capsule depressurization to happen due to precautions already taken to reduce this, if it did, any capsules that were in the tube at the time would fall back on emergency brakes. If a more prominent event of depressurization were to occur, oxygen masks would be distributed to each passenger similar to an airplane so not to lose consciousness and the broken pod would be replaced at the nearest station.

Accelerometer for Added Certainty:

We will also hold an accelerometer on the capsule to determine speed, velocity, and acceleration instantaneously, which will be rerouted to us on our computer in case we need to make adjustments manually or even halt the pod with our braking mechanism that we will test before hand to make sure that we can brake as well as to determine the effectiveness of our braking system.

Access Point:

The access point that we will be using was the AP recommended by SpaceX (Cisco IW3700).

Folding Structure

The folding structure has a protective inner layer is there in the case that the outer layer cracks and depressurizes, and this layer will prevent the depressurization of the passenger cabin. Also, the batteries are within one of the bottom triangular prisms and they are separated through 304L Stainless Steel material by half an inch of material. Thus, water will not be able to diffuse through the steel and our batteries will be safe. Also, there is a layer of vacuum sealant material (hypothetically called C-Seal through Herber Aircraft) and this material will seal a crack that forms in either the outer layers of the folding including the triangular prisms as well as if a crack forms in the inner protective layer that shields the passengers. There are holes within the connection ribs that hold the inner protective layer to the outer layer with the triangular prisms attached to the outside of this layer. The holes are there for fluid flow of the vacuum sealant in the case that the connection ribs between the inner and outer layer cracks as well, to seal those spaces.

Position of the Logger within the Capsule:

The logger will be placed aligned with the x-axis of the capsule within 10° of the nominal direction of travel (parallel to the direction of travel). The position of the xy plane will be within 5° to the tangent surface of the bottom of the track at all times. The logger port will be placed such that a technician may access the logger to install it. Specifically, the logger will be placed at the back end of the capsule in one of the triangular prisms such that the technician will be able to install it after we open the tail hatch to the pod. The tail hatch will open and the fold near the rear will obtain a slot for the technician to easily place it within the capsule. The Logger will have a specially designed mount that it can hook up to that is within the triangular prism in the case that the logger would otherwise not lie within 5° to the xy plane of the track.

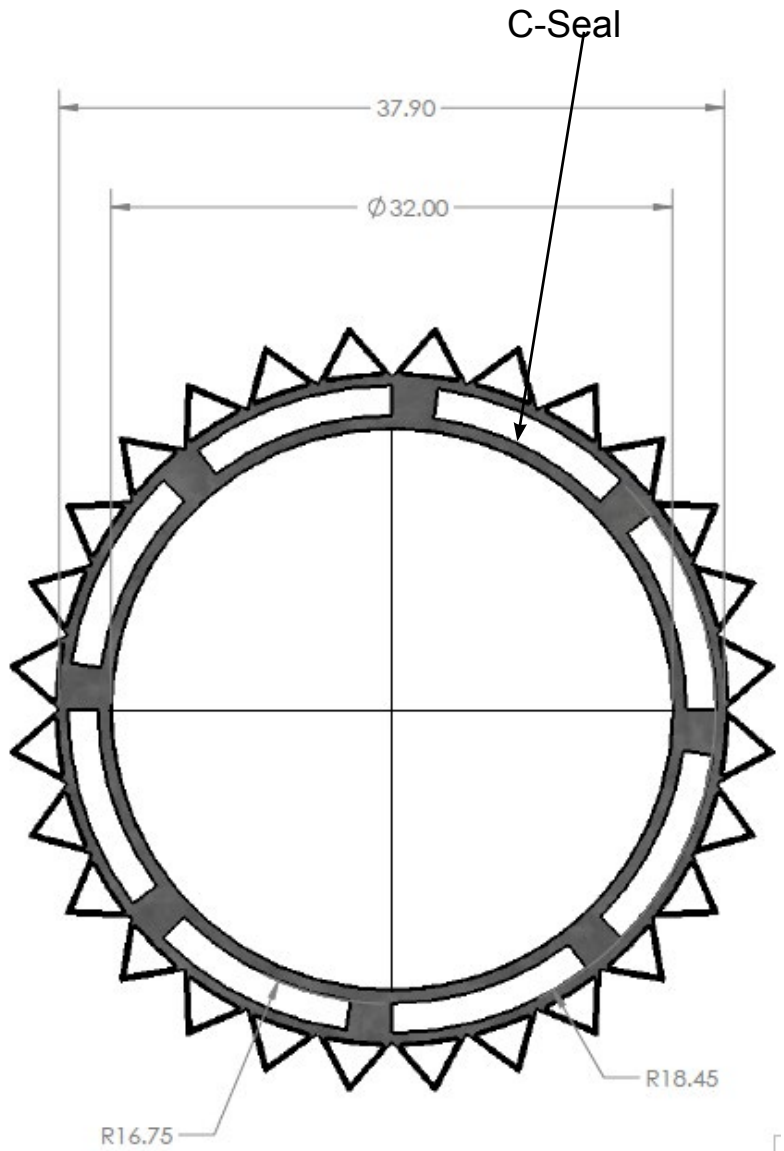
Pod Safety

The Hyperloop capsule is made to transport long distances in a short amount of time. When it comes to safety this type of transportation can be compared to aeronautical flight standards. Some cautions that can be reduced in the Hyperloop include rain, snow, ice, and extreme temperatures. These precautions are not needed for much acknowledgement due to the fact that the Hyperloop tubes are made to withstand all of the above. Should any stalling or sudden stops of pods occur, capsules are programmed to fall back on emergency brakes, following a routine phase change in deceleration and then eventually coming to a stop. Maintenance will then make calls from the pod to lead it to the nearest station where ground crew will help quickly replace the capsule, broken compressor, or any other issue with the subsystems and proceed with the journey.

HAZARDOUS MATERIALS

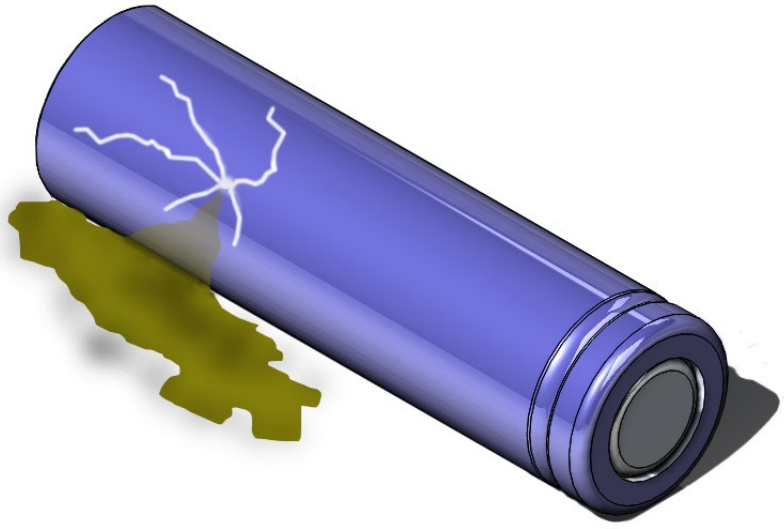
Vacumn Sealant

In case of pressure flucuations between the folding structure that runs all around the tube, (1) c-seal is a sealant that overcomes both heat and pressure and is used primilarly in aerospace engineering. The whole idea behind applying C-seal to the gap is to close any crack that can potentially happen under pressure. The seal is promised to help in internal, external, axial, and radial pressure. C-seal will be inputed within the spaces between the foldings. The only caution is C-seal is primariliy used to withstand high temperatures, and with the capsule the idea behind the C-seal is to help with not just high temperatures, but be extremly resilent to fixing pod breakage.



Battery Leaks

If a battery leak were to occur, if it's a gel or liquid leak maintenance crew is required to wear acid-resistant gloves and goggles when handling the material. Polyethylene plastic bags should be kept for disposal of these batteries. According to the Material/Product Safety Data Sheet (MSDS),(3) lithium ion batteries are at low risk of flammability, but if it were to break they do react strongly with water. But the c-seal sealed in between the inputs incase of cracks will prevent any other liquids from approaching the leaked batteries. If however the C-seal contains water, the lithium ion could react viciously.



Wheels

Wheel of Hyperloop is made from either aluminum or magnesium alloys. These materials provide a strong, lightweight wheel that requires very little maintenance. Aluminum and magnesium alloys have a high melting point. Alloys are much lighter making it quick for acceleration and deceleration. However, alloys are also incredibly flammable. Even though it takes a high melting point for any flammability to occur to magnesium alloys, it also is a potential hazard.



Compressed Air

If Compressed air(2) were in anyway to reach the passenger, it can enter the blood stream and cause an embolism. To avoid this risk our air compressors are located in the front of the passenger seating, and in case of an explosion, a nearby shut off system will be tangible to the pod maintenance or personnel. Also to ensure safety is making sure the air tanks are compatible with the level of psi being admitted into these tanks. If Compressors were to erupt for any reason, the frontal skin of the pod that holds the passengers will be made of titanium, which will intentionally stop any exposure to compressed air.

References

1. "C-seals." American Seal & Engineering. American Seal & Engineering Co., 2014. Web. 27 Oct. 2015. <<http://www.ameriseal.com/#!ameriseal-products-c-seals/civg>>.
2. Gonzales, Michelle. "Compressed Air Safety." Safety Toolbox Topics. Safety Toolbox Topics, 2015. Web. 20 Oct. 2015. <<http://safetytoolboxtopics.com/General/compressed-air-safety.html>>.
3. "Material Safety Data Sheet." Global Technology Systems, Inc., 2015. Web. 20 Oct. 2015. <http://www.analog.com/media/en/technical-documentation/application-notes/hdr202li_hd220rli_battery_msd.pdf>.

DVC HYPERLOOP TEAM Z-TYPHON



TEAM DESCRIPTION

Over the course of a few months, Team Z-Typhon had conducted a series of capsules, compressors, rotors, and more to contribute to the Hyperloop competition. However, prior to the final design many complications and obstacles had to be overcome. With an independent study class starting with 38 curious students ready to participate in the competition quickly dropped to 15 over the course of a few weeks. But with the experience of the DVC architecture department, and the assistance of aeronautical engineers and engineer enthusiasts, and many hours spent extracting information to a newborn project, the students at Diablo Valley Community College designed the final capsule with innovative design, counter rotating motors, and the folding apparatus. With the Hyperloop having both electricity and air being its main components of power, the name “Z-typhon” , “ZT” or “Zeus Typhon” abrupted from the story of the battle between the god of thunder, and Typhon the wind titan. This battle was between an air titan and a thunder titan son. Zeus won and overcame the air titan with his lightning and team of gods. This resembles the goal of the Hyperloop, which is to overcome the Kantrowitz limit by taking in air and expelling it through the back, while using a battery to overcome this process. Our goal is to overcome a high drag and to flow through the tube efficiently with the least air drag on the pod. To do this we use the compressors and the lithium ion batteries to power our pod.

TEAM MEMBERS

- Daniel DiNotta
- Taylor Kendall
- Thom Bardin
- Janeth Miranda
- Willy Ma
- Rebecca Johnson
- David Ye
- Shiyao Zhai
- Hao Wang
- Sang yun John
- Hansaem Lee
- Mouzima Mousumi

TEAM CAPTAIN

- Ross Pappas

TEAM ADVISORS

- Daniel Abbott
- Bruce Brumfield
- Chi Ishikawa

Team Z-typhon wants to Design a Pod and attend design weekend!